DOCUMENT RESUME

ED 183 825 CE 024 385

TITLE Military Curricula for Vocational & Technical Education. Construction Electrician/Power and Communications Cable Splicing, 5-3.
INSTITUTION Naval Construction Training Center, Gulfport, Miss.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.
SPONS AGENCY Bureau of Occupational and Adult Education (DHEW/OE), Washington, D.C.
PUB DATE Feb 77
NOTE 734p.; Not available in hard copy due to light, small type.

EDRS PRICE MF04 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Behavioral Objectives; *Building Trades; Communications; Course Descriptions; Curriculum Guides; *Electrical Systems; *Electricians; Grade 12; High Schools; Learning Activities; Postsecondary Education; Teaching Guides; Technology; *Telephone Communications Systems; *Trade and Industrial Education; Workbooks
IDENTIFIERS Cable Assemblers; Military Curriculum Project

ABSTRACT

This curriculum outline, instructor's guide, and student's guide for a secondary-postsecondary-level course in construction electrician/power and communications cable splicing are one of a number of military-developed curriculum packages developed for adaptation to vocational instruction and curriculum development in a civilian setting. Purpose stated for the 341-hour course is to provide knowledge of the techniques and procedures for (1) joining power cable employing straight and branched joints, terminations, and live end caps for aerial and underground cable systems and (2) constructing straight budge and butt splices in lead and plastic sheathed communication cable. The plan of instruction is based on the following four-unit outline: Introduction (1 lesson, 5 hours), Telephone Cable Splicing (3 lessons, 91 hours), Power Cable Splicing (12 lessons, 238 hours), and Planning and Estimating (2 lessons, 7 hours). The curriculum outline lists objectives, hours of instruction, references, and equipment needs. Contents of the instructor's guide include instructional materials, objectives, criterion tests, homework, and outlines of instruction, including instructor and student activities. The student's guide contains objectives, information sheets, job sheets, and review exercises. A required chapter from a recommended text is also provided. (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED183825

Military Curricula for Vocational & Technical Education

CE 024 386

CONSTRUCTION ELECTRICIAN/POWER
AND COMMUNICATIONS CABLE SPLICING

5-3

U.S. DEPARTMENT OF HEALTH
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY

This military technical training course has been selected and adapted by The Center for Vocational Education for "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education," a project sponsored by the Bureau of Occupational and Adult Education, U.S. Department of Health, Education, and Welfare.

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

Classroom Course

CONSTRUCTION ELECTRICIANS / POWER AND COMMUNICATIONS CABLE SPLICING

CI-A-721-0023

Developed by:
United States Navy

Development and Review Dates:
February 1977

Occupational Area:
Communications

Target Audiences:
Grade 12 - Adult

Print Pages: 591

Microfiche: 10

Availability:
Vocational Curriculum
Coordination Centers

Contents:	Type of Materials:						Instructional Design:				Type of Instruction:	
	Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Group Instruction:	Individualized:
Unit 1.1 Introduction	●		●				●		●	x	●	
Unit 1.2 Telephone Cable Splicing	●		●		●	x	●		●	x	●	
Unit 1.3 Power Cable Splicing	●		●		●	x	●		●	x	●	
Unit 1.4 Planning & Estimating	●		●		●		●		●	x	●	

X Materials are recommended but not provided.

Course Description:

The course is designed to provide knowledge of the techniques and procedures for joining power cable employing straight and branched joints, terminations, and live end caps for aerial and underground cable systems. Construct straight budge, and butt splices in lead and plastic sheathed communication cable. The four topic areas cover 341 hours of instruction.

Unit 1.1 - Introduction cosists of one lesson on safety policies requiring 5 hours of instruction.

Unit 1.2 - Telephone Cable Splicing contains 3 lessons covering 91 hours of instruction.
Lead Sheathed Cable Joints (41 hours)
Plastic Sheathed Cable Joints (36 hours)
Join Plastic and Lead Sheathed Cable (14 hours)

Unit 1.3 - Power Cable Splicing consists of 12 lessons requiring 238 hours of instruction.
Straight Splice, 5 and 15 kv (3 lessons, 62 hours)
Termination Splice, 5 and 15 kv (3 lessons, 29 hours)
Cross-linked Polyethylene Insulated Cable Splicing (1 lesson, 43 hours)
Straight Transition Splice (1 lesson, 25 hours)
Branch Splice (1 lesson, 25 hours)
Trifurcation/Transition (1 lesson, 37 hours)
Pulling Eye Attachment (1 lesson, 5 hours)
Live End Cap (1 lesson, 11 hours)

Unit 1.4 - Planning and Estimating has two lessons covering 7 hours of instruction in telephone and power cable applications.

The course contains both teacher and student materials. Printed instructor materials include a curriculum outline listing objectives, hours of instruction and references and an instructor's guide further outlining instruction and instructor activities. The student's guide contains objectives, information sheets, job sheets, and review exercises.

Classroom
Course 5-5

Construction Electricians/Power and Communications Cable Splicing
CIA-721-0023

Table of Contents

	Page
Curriculum Outline	1
Instructor's Guide	54
Student's Guide	347
"Telephone Cable Splicing" Chapter 12, Technical Manual NAVPERS 10636-G *Construction Electrician 3 & 2*	561

Units	Instructor Guide	Student Guide
Introduction	60	353
Telephone Cable Splicing	82	371
Power Cable Splicing	169	454
Planning and Estimating	329	547

FOR OFFICIAL USE ONLY

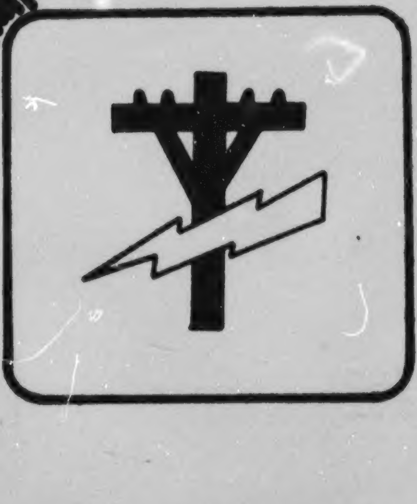
CURRICULUM OUTLINE
for
CONSTRUCTION ELECTRICIANS /POWER & COMMUNICATIONS CABLE SPLICING

C1 A-721-0023

PREPARED FOR
CHIEF OF NAVAL TECHNICAL TRAINING

PREPARED BY
NAVAL
CONSTRUCTION
TRAINING
CENTER

GULFPORT, MS. 39501
FEBRUARY 1977



2

TABLE OF CONTENTS

FRONT MATTER PAGE

Cover Page - 1

Foreword - ii

Table of Contents- iii

Course Data Page - v

OUTLINE OF INSTRUCTION

Unit 1.1 INTRODUCTION - 1

Lesson Topic 1.1.3 SAFETY POLICIES- - - - - - - - - - - - - - - - - 4

Unit 1.2 TELEPHONE CABLE SPLICING - - - - - - - - - - - - - - - - 7

Lesson Topic 1.2.1 LEAD SHEATHED CABLE JOINTS - - - - - - - - - - - 8

Lesson Topic 1.2.2 PLASTIC SHEATHED CABLE JOINTS- - - - - - - - - - 9

Lesson Topic 1.2.3 JOIN PLASTIC AND LEAD SHEATHED CABLE - - - - - - 10

UNIT 1.3 POWER CABLE SPLICING - - - - - - - - - - - - - - - - - - 11

Lesson Topic 1.3.1 STRAIGHT SPLICE, 5 KV, RR, AWG #8- - - - - - - - 13

Lesson Topic 1.3.2 STRAIGHT AND BRANCH SPLICES, 5 KV, R-L, AWG #4/0 - - - - - - - - - - - - - - - - - - 15

Lesson Topic 1.3.3 TERMINATION SPLICE, 5 KV, VARNISHED CAMBRIC INSULATED-LEAD SHEATHED AWG #4/0 POWER CABLE - - 17

Lesson Topic 1.3.4 CROSS-LINKED POLYETHLENE INSULATED CABLE SPLICING - - - - - - - - - - - - - - - - 19

OUTLINE OF INSTRUCTION (CONT'D) PAGE

Lesson Topic 1.3.5 TERMINATIONS WITH XLP 5 KV CABLE - - - - - - - - - - 21

Lesson Topic 1.3.6 STRAIGHT TRANSITION SPLICE W/OIL STOP, 5 KV, 1/C, XLP TO VCL- - - - - - - - - - - - - - - - 23

Lesson Topic 1.3.7 BRANCH SPLICE, 15 KV, VCL, AWG #4/0- - - - - - - - 25

Lesson Topic 1.3.8 STRAIGHT SPLICE, 15 KV, XLP, URD-ALUMINUM- - - - 27

Lesson Topic 1.3.9 TERMINATION (ALL-TAPE), OUTDOOR W/RAINSHIELD, 15 KV, XLP INSULATED, AWG #2/0, 3/C- - - - - - - 29

Lesson Topic 1.3.10 TRIFURCATION/TRANSITION 1 WAY-3 WAY, 15 KV, THREE 1/C CROSS-LINKED POLYETHLENE, SHIELDED TO A PAPER INSULATED-LEAD SHEATHED 3/C, POWER CABLE - 31

Lesson Topic 1.3.11 PULLING-EYE ATTACHMENT ON A 5 KV RUBBER-LEAD, 1/C POWER CABLE - - - - - - - - - - - - - - - 33

Lesson Topic 1.3.12 LIVE END CAP ON A 15 KV, 1/C, VARNISHED-CAMBRIC INSULATED-LEAD COVERED POWER CABLE- - - 35

Unit 1.4 PLANNING AND ESTIMATING- - - - - - - - - - - - - - - - - - - 37

Lesson Topic 1.4.1 PLANNING AND ESTIMATING (TELEPHONE CABLE)- - - - 38

Lesson Topic 1.4.2 PLANNING AND ESTIMATINS (POWER CABLE)- - - - - - 39

ANNEXES

Annex 1 - Equipment Requirements Lists - - - - - - - - - - - - - - - - - 40

Annex 2 - Bibliography - 58

MASTER SCHEDULE- 61

4

COURSE DATA PAGE

COURSE MISSION: To train selected enlisted Construction Electricians in advanced instructions on the techniques and procedures for joining power cable employing straight and branched joints, terminations, and live end caps for aerial and underground cable systems. Construct straight, bridge, and butt splices in lead and plastic sheathed communication cable.

OUTLINE OF INSTRUCTION

UNIT 1.1 INTRODUCTION

Estimated Contact Hours allotted this unit:

Classroom	Practical
5 Hours	0 Hours

TERMINAL OBJECTIVE:

Supported Entirely by this Unit

#1.1 Upon completion of this unit of instruction, the student will have registered for the course, received course books, answered questions pertaining to key points on the organization, mission, and regulations of NAVCONSTRACEN and CBC, reviewed class schedule, been introduced to class counselor, stated the standards of the school, described the benefits that can be derived from good study techniques, stated how to report accidents or fire, listed the safety practices that are enforced in the school, answered orally specific questions relating to the duties and responsibilities of a supervisor and completed a pre-test to establish his level of previous training and experience.

UNIT 1.2 TELEPHONE CABLE SPLICING

Estimated Contact Hours allotted this unit:

Classroom	Practical
11 Hours	80 Hours

TERMINAL OBJECTIVE

Supported entirely by this unit

#1.2 Upon completion of this unit, the student will be able to splice telephone cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

1. Lead sheathed telephone cable
   a. Straight splice - 7.0 hours
   b. Butt splice - 7.0 hours
   c. Bridge splice - 7.0 hours
2. Plastic sheathed telephone cable
   a. Straight splice - 4.0 hours
   b. Butt splice - 4.0 hours
   c. Bridge splice - 4.0 hours
3. Plastic sheathed telephone cable to lead sheathed telephone cable.
   a. Straight splice - 7.0 hours

All splices will be constructed in accordance with TM 11-372-1 through 8 and Job Sheet CE "C" 1.2J series and will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

6

LESSON TOPIC 1.2.1 LEAD SHEATHED CABLE JOINTS

Estimated Contact Hours Allotted This Lesson Topic:

Classroom	Practical
2 Hours	39 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.2 Upon completion of this unit the student will be able to splice telephone cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

1. Lead sheathed telephone cable
   - a. Straight splice - 7.0 hours
   - b. Butt splice - 7.0 hours
   - c. Bridge splice - 7.0 hours

All splices will be constructed in accordance with TM 11-372-1 through 8 and Job Sheet CE "C" 1.2J series and will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.2.1 CONSTRUCT a straight, butt, and bridge splice in a lead sheathed telephone cable utilizing the appropriate tools and materials in accordance with TM 11-372-1, 2, 5, 6, and 7; and Construction Electrician 3 & 2, NAVPERS 10636-G; and Job Sheets CE "C" 1.2.1J, 1.2.1.2J, and 1.2.1.3J without deviation. All splices will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

LESSON TOPIC 1.2.2 PLASTIC SHEATHED CABLE JOINTS

Estimated Contact Hours Allotted This Lesson Topic:

Classroom	Practical
7 Hours	29 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.2 Upon completion of this unit, the student will be able to splice telephone cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

1. Plastic sheathed telephone cable
    - a. Straight splice - 4.0 hours
    - b. Butt splice - 4.0 hours
    - c. Bridge splice - 4.0 hours

All splices will be constructed in accordance with TM 11-372-1 through 8 and Job Sheet CE "C" 1.2J series and will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.2.2 CONSTRUCT a straight, butt, and bridge splice in a plastic sheathed telephone cable utilizing the proper tools and materials in accordance with TM 11-372-1, 2, 5, and 6; and Job Sheets CE "C" 1.2.2.1J, 1.2.2.2J, and 1.2.2.3J without deviation. All splices will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

8

LESSON TOPIC 1.2.3 JOIN PLASTIC AND LEAD SHEATHED CABLE

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
2 Hours	12 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.2 Upon completion of this unit the student will be able to splice telephone cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

1. Plastic sheathed telephone cable to lead sheathed telephone cable.
   a. Straight splice - 7.0 hours

All splices will be constructed in accordance with TM 11-372-1 through 8 and Job Sheet CE "C" 1.2J series and will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.2.3 CONSTRUCT a straight splice in a plastic sheathed and a lead sheathed telephone cable utilizing the proper tools and materials in accordance with TM 11-372-1, Construction Electrician 3 & 2, NAVPERS 10636-G, and Job Sheet CE "C" 1.2.3.1J without deviation. The splice will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

UNIT 1.3 POWER CABLE SPLICING

Estimated Contact Hours allotted this unit:

Classroom	Practical
10 Hours	220 Hours

TERMINAL OBJECTIVE:

Supported entirely by this Unit

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.
    a. Rubber insulation-rubber sheathed cable, single conductor - straight splice - 2.0 hours
    b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours
    c. Rubber insulation-lead sheathed cable, single conductor branch splice - 14.0 hours
    d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours
    e. XLP shielded cable, single conductor - straight splice - 3.0 hours
    f. XLP unshielded cable, single conductor - straight splice - 4.0 hours.
    g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours
    h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours
    i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours

2. Splice single and three conductor, [illegible] kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.
    a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
    b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours
    c. XLP shielded cable, three conductor - termination splice - 7.0 hours
    d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours

10

UNIT 1.3 POWER CABLE SPLICING (Continued)

3. Splice special joints in single conductor, 5 kv and 15 kv power cable in the below listed types of cable. The type of special joint to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. 5 kv, rubber insulation lead sheathed cable, single conductor - pulling eye joint - 2.0 hours
   b. 15 kv, varnished cambric cable, single conductor - live end cap - 6.0 hours.

These splices and special joints will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.00 series without deviation. All splices and special joints, with the exception of the pulling eye, will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective. The pulling eye joint will be required to withstand a pulling force of 6000 pounds on a single conductor cable or 5000 pounds on a three conductor cable in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

17

LESSON TOPIC 1.3.1 STRAIGHT SPLICE, 5 kv, RR, AWG #8

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
2 Hours	5 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.
   a. Rubber insulation-rubber sheathed cable, single conductor - straight splice - 2.0 hours
   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours
   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours
   e. XLP shielded cable, single conductor - straight splice - 3.0 hours
   f. XLP unshielded cable, single conductor - straight splice - 4.0 hours
   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours
   h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours
   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

12 LESSON TOPIC 1.3.1 - ENABLING OBJECTIVE (cont'd)

When the student completes this lesson topic, he will be able to:

#1.3.1 CONSTRUCT a straight splice in a 5 kv rubber insulated-rubber sheathed (R-R), AWG #8 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio and Job Sheet CE "C" 1.3.1.1J without deviation. The splice will be required to withstand an acceptance test of 33.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.2 STRAIGHT AND BRANCH SPLICES, 5 kv, R-L, AWG #4/0

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
3 Hours	36 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Rubber insulation-rubber sheathed cable single conductor - straight splice - 2.0 hours
   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours
   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours
   e. XLP shielded cable, single conductor - straight splice - 3.0 hours
   f. XLP unshielded cable, single conductor - straight splice - 4.0 hours
   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours
   h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours
   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.2 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.2 CONSTRUCT a straight and a branch splice in a 5 kv rubber insulated-lead sheathed (R-L), AWG #4/0 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.2.1J without deviation. The splice will be required to withstand an acceptance test of 33.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.3 TERMINATION SPLICE, 5 kv, VARNISHED CAMBRIC INSULATED-LEAD SHEATHED AWG #4/0

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	6 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.
    a. Rubber insulation-rubber sheathed cable single conductor - straight splice - 2.0 hours
    b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours
    c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
    d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours
    e. XLP shielded cable, single conductor - straight splice - 3.0 hours
    f. XLP unshielded cable, single conductor - straight splice - 4.0 hours
    g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours
    h. XLP shielded or unshielded cable, single conductor - termination splice, - 2.0 hours
    i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.3 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.3 CONSTRUCT a termination splice in a 5 kv, single conductor, varnished cambric insulated-lead sheathed (VCL), AWG #4/0 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.3.1J without deviation. The splice will be required to withstand an acceptance test of 37.2 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.4 CROSS-LINKED POLYETHLENE INSULATED CABLE SPLICING

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
3 Hours	40 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Rubber insulation-rubber sheathed cable single conductor - straight splice - 2.0 hours
   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours
   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours
   e. XLP shielded cable, single conductor - straight splice - 3.0 hours
   f. XLP unshielded cable, single conductor - straight splice - 4.0 hours
   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours
   h. XLP shielded or unshielded cable, single conductor - termination splice, - 2.0 hours
   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.4 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic

When the student completes this lesson topic, he will be able to:

#1.3.4 CONSTRUCT the following splices in 5 kv Cross-Linked Polyethlene insulated cables utilizing the appropriate tools and materials in accordance with Terminations and Splices - Theory - Practice, PLM Products, 4699 W. 150th St., Cleveland, Ohio and Job Sheet as indicated by each type cable.

1. XLP shielded, single conductor, AWG # 4/0 power cable - CE "C" 1.3.4.1J.
2. XLP unshielded, single conductor, AWG #4/0 power cable - CE "C" 1.3.4.2J.
3. XLP shielded or unshielded, three conductor, AWG #4/0 power cable - CE "C" 1.3.4.3J.

The splices will be required to withstand an acceptance test of 27.6 kv for 15 minutes on shielded cable and 28.8 kv for 15 minutes on unshielded cable in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.5 TERMINATION WITH XLP 5 kv CABLE

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	6 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Rubber insulation-rubber sheathed cable single conductor - straight splice - 2.0 hours
   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours
   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours
   e. XLP shielded cable, single conductor - straight splice - 3.0 hours
   f. XLP unshielded cable, single conductor - straight splice - 4.0 hours
   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours
   h. XLP shielded or unshielded cable, single conductor - termination splice, - 2.0 hours
   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.5 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.5 CONSTRUCT a termination splice in 5 kv, single conductor, AWG #4/0, Cross-Linked Polyethlene insulated power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3.5.1J without deviation. The splice will be required to withstand an acceptance test of 27.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.6 STRAIGHT TRANSITION SPLICE W/OIL STOP, 5 kv, 1/C, XLP TO VCL

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	24 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

    a. Rubber insulation-rubber sheathed cable single conductor - straight splice - 2.0 hours
    b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours
    c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
    d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours
    e. XLP shielded cable, single conductor - straight splice - 3.0 hours
    f. XLP unshielded cable, single conductor - straight splice - 4.0 hours
    g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours
    h. XLP shielded or unshielded cable, single conductor - termination splice, - 2.0 hours
    i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.6 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.6 CONSTRUCT a straight transition splice in a 5 kv, single conductor, AWG #4/0, Cross-Linked Polyethlene insulated power cable to a 5 kv, single conductor, AWG #4/0, Varnished-Cambric insulated-lead covered power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.6.1J without deviation. The splice will be required to withstand an acceptance test of 27.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.7 BRANCH SPLICE, 15 kv, VCL, AWG #4/0

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	24 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.
   a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
   b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours
   c. XLP shielded cable, three conductor - termination splice - 7.0 hours
   d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.7 CONSTRUCT a branch splice in a 15 kv varnished-cambric insulated-lead sheathed (VCL), AWG #4/0 power cable utilizing the appropriate

24

LESSON TOPIC 1.3.7 - ENABLING OBJECTIVE (cont'd)

tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.7.1J without deviation. The splice will be required to withstand an acceptance test of 93.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.8 STRAIGHT SPLICE, 15 kv, XLP, URD-ALUMINUM

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	15 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.
   a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
   b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours
   c. XLP shielded cable, three conductor - termination splice - 7.0 hours
   d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

26

LESSON TOPIC 1.3.8 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.8 CONSTRUCT a straight splice in a 15 kv cross-linked polyethlene insulated, AWG #1/0, with concentric neutral power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3.8.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.9 TERMINATION (ALL-TAPE), OUTDOOR W/RAINSHIELD, 15 kv, XLP INSULATED, AWG #2/0, 3/C

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	15 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

    a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
    b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours
    c. XLP shielded cable, three conductor - termination splice - 7.0 hours
    d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.8 CONSTRUCT a termination splice in 15 kv, cross-linked polyethylene (XLP), AWG #2/0, 3 conductor power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.9.1J without deviation. The splice will be required to withstand an acceptance test of 52.[illegible] kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.10 TRIFURCATION/TRANSITION 1 WAY-3 WAY, 15 kv, THREE 1/C CROSS-LINKED POLYETHLENE SHIELDED TO A PAPER INSULATED-LEAD SHEATHED 3/C POWER CABLE

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
2 Hours	35 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.
    a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours
    b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours
    c. XLP shielded cable, three conductor - termination splice - 7.0 hours
    d. XLP shielded or unshielded to paper insulated-lead covered (PLIC) cable, three conductor - straight transition splice - 21.0 hours

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.10 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.10 CONSTRUCT a straight trifurcation/transition splice with three 15 kv, single conductor, cross-linked polyethlene power cables to a 15 kv, three conductor, paper insulated-lead covered (PILC) power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.10.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

LESSON TOPIC 1.3.11 PULLING-EYE ATTACHMENT ON A 5 kv RUBBER-LEAD, 1/C POWER CABLE

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	4 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice special joints in single conductor, 5 kv and 15 kv power cable in the below listed types of cable. The type of special joint to be made in each cable and the time limit prescribed are as indicated by each cable.
    - a. 5 kv, rubber insulation-lead sheathed cable, single conductor - pulling eye joint - 2.0 hours
    - b. 15 kv, varnished cambric cable, single conductor - live end cap - 6.0 hours

These splices and special joints will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices and special joints, with the exception of the pulling eye, will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective. The pulling eye joint will be required to withstand a pulling force of 6000 pounds on a single conductor cable or 5000 pounds on a three conductor cable in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

LESSON TOPIC 1.3.11 (Continued)

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.11 CONSTRUCT a pulling eye attachment on a 5 kv rubber insulated-lead sheathed, single conductor power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.11.1J without deviation. The pulling eye joint will be required to withstand a pulling force of 6000 pounds in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

32

LESSON TOPIC 1.3.12 LIVE END CAP ON A 15 kv, 1/C, VARNISHED-CAMBRIC INSULATED-LEAD COVERED POWER CABLE

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
1 Hours	10 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice special joints in single conductor, 5 kv and 15 kv power cable in the below listed types of cable. The type of special joint to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. 5 kv, rubber insulation-lead sheathed cable, single conductor - pulling eye joint - 2.0 hours
   b. 15 kv, varnished cambric cable, single conductor - live end cap - 6.0 hours

   These splices and special joints will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices and special joints, with the exception of the pulling eye, will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective. The pulling eye joint will be required to withstand a pulling force of 6000 pounds on a single conductor cable or 5000 pounds on a three conductor cable in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.3.12 CONSTRUCT a live end cap on a 15 kv, single conductor, varnished-cambric insulated-lead covered power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.12.1J without deviation. The live end cap will be required to withstand an acceptance test of 93.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

UNIT 1.4 PLANNING AND ESTIMATING

Estimated Contact Hours allotted this unit:

Classroom	Practical
14 Hours	0 Hours

TERMINAL OBJECTIVE

Supported entirely by this Unit

#1.4 Upon completion of this unit the student will be able to plan and estimate for mandays and materials to make telephone cable and power cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook. The mandays for each splice will be estimated in accordance with NAVFAC P-405, Seabee Planner's and Estimator's Handbook and materials estimate will be within + 5% of an instructor prepared Material Take Off (MTO) for each splice.

LESSON TOPIC 1.4.1 PLANNING AND ESTIMATING (TELEPHONE CABLE)

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
7 Hours	0 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.4 Upon completion of this unit the student will be able to plan and estimate for mandays and materials to make telephone cable and power cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook. The mandays for each splice will be estimated in accordance with NAVFAC P-405, Seabee Planner's and Estimator's Handbook and materials estimate will be within ± 5% of an instructor prepared Material Take Off (MTO) for each splice.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.4.1 PLAN and ESTIMATE for mandays and materials to make telephone cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook without deviation. The estimate for materials of each splice will be taken from the appropriate job sheet setting up the procedure for its construction and must be within ± 5% of an instructor prepared Material Take Off (MTO) on that splice.

LESSON TOPIC 1.4.2 PLANNING AND ESTIMATING (POWER CABLE)

Estimated Contact Hours Allotted this Lesson Topic:

Classroom	Practical
7 Hours	0 Hours

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.4 Upon completion of this unit, the student will be able to plan and estimate for mandays and materials to make telephone cable and power cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook. The mandays for each splice will be estimated in accordance with NAVFAC P-405, Seabee Planner's and Estimator's Handbook and materials estimate will be within + 5% of an instructor prepared Material Take Off (MTO) for each splice.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

When the student completes this lesson topic, he will be able to:

#1.4.2 PLAN and ESTIMATE for mandays and materials to make power cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook without deviation. The estimate for materials of each splice will be taken from the appropriate job sheet setting up the procedure for its construction and must be within ± 5% of an instructor prepared Material Take Off (MTO) on that splice.

36

ANNEX I - EQUIPMENT

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Portable DC Hypot HV Tester	6625-00-298-9638	1	$3,115.00
Telephone Test Set TS 420/U 76C	Western Elect.	7	300.00
Volt-Ohmeter, Mod. 240	Simpson	1	75.00
Exploring Coil, 101B	Western Elect.	1	25.00
Exploring Coil, 75A	Western Elect.	1	25.00
Head Set, Tele/Test	Western Elect.	14	40.00
Compression Tool, Y-34-A, Hyd 9 Ton	9Q5120-00-[illegible]93-2316 Burndy Mfg. Co.	1	192.59
Compression Tool, MY 29-3	Burndy Mfg. Co.	1	55.00
Compression Tool T&B # TBM-8	Thomas and Betts	1	150.00
Compression Tool T&B # TBM-Kit	Thomas and Betts	1	165.[illegible]
Pliers, Eagle Beak	B. S. Barnard Co.	2	20.00
Chain Hoist	A. B. Chance Co.	1	150.00
Dynamometer	A. B. Chance Co.	1	75.00
Saw, Cableman's	5110-00-273-0101	4	4.74
Saw, Hacksaw	5110-00-289-9657	2	1.97
Bond Drift Plugs, 1"	General Machine Products GMP 6636-2	2	6.00
Bond Drift Plugs, 1¼"	GMP 6636-3	2	6.50
Bond Drift Plugs, 1½"	GMP 6636-4	2	7.00
Bond Drift Plugs, 1 3/4"	GMP 6636-5	2	7.50

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Bond Drift Plugs, 2"	General Machine Products GMP 6636-6	2	8.50
Bond Drift Plugs, 2½"	GMP 6636-8	2	9.50
Bond Drift Plugs, 2 3/4"	GMP 6636-9	2	11.50
Bond Drift Plugs, 3"	GMP 6636-10	2	13.00
Bond Drift Plugs, 3½"	GMP 6636-11	2	18.50
Bond Drift Plugs, 4"	GMP 6636-12	2	20.00
Potheads, Capnut	Gulf & Western G&W 5 kv WS-31	4	49.00
Vice, Machinists	5120-00-293-1439	2	46.80
"B" End Platemold	General Machine Products GMP CAT. 7292	1	107.00
Soldering Copper, w/Handle	GMP CAT. 67223	5	9.00
Cable Cutter	H. K. Porter CAT. NO. 190 CS	1	56.00
Cable Cutter, 32"	Somerset CAT. NO. UT 366 FR	1	90.88
Cable Cutter, 20½"	Somerset CAT. NO. UT 366 FR	1	85.00
Cable Cutter, Hydraulic, 3"	H. K. Porter CAT. NO. 179089	1	157.00
Hacksaw, Power	Mfg. Keller Mod. 3-B	1	380.00
Kettle, Compound, 3 gal.	5120-00-596-1074	1	21.80
Kettle, Compound, 5 qt.	General Machine Products GMP 6130	2	25.00
Furnace, Butane, w/tank	Goss Gas Inc.	4	86.46
Tank, Acetylene, "B" 20 cu. ft.	Goss Gas Inc.	2	50.00

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Tank, Acetylene, "MC" 10 cu. ft.	Goss Gas Inc.	3	30.00
Furnace, Melting, Elect.	Gen. Elect. GE2881146	15	20.00 Est.
Windshield, used w/Furnace	Automatic Elect. AWS577876	3	36.52
Heating Unit, 1000W, f/Furnace 115V	Gen. Elect. GE3A228G3	15	20.00 Est.
Pot, Solder, Melting, 5"	5120-00-540-4134	1	2.11
Handle, Pot Hook	General Machine Products GMP 7170	2	4.00
Pan, Solder, Lg.	GMP 6874	4	6.00
Pan, Solder, Sm	GMP 6877	4	6.00
Dipper, Parafin	GMP 6679	1	3.50
Pot, Parafin, 12" X 9"	5120-00-293-3550	3	13.39
Test Pick	Western Elect. GMT-6491	4	3.00
Die Set, Metal, ¼" Numbers	5110-00-289-0003	1	5.41
Die Set, Metal, ¼" Letters	5110-00-289-0007	1	25.06
Pencil Tool, PT10B	PLM	1	30.00
Pencil Tool, PT20B	PLM	2	30.00
Pencil Tool, PT 40C	PLM	2	35.00
Pencil Tool, PT250C	PLM	2	35.00
Insul. Stripper, 1SQ	PLM	4	38.50
Resin Pressure Gun "E-4"	3M Company	4	46.73
Furnace, Gasoline	A.E. 5573986	4	27.00
Lead Sleeve Slitter "B"	GMP 7449	3	3.75

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Wires, f/Slitter	GMP 7449-W General Machine Products	20	.40
Drill, Cable .280	GMP 6797	3	9.00
Drill, Cable .480	GMP 7533	2	17.50
Clamp, Pressure Test	GMP 6565	4	8.00
Pump, Pressure Test "B"	GMP 7072	2	22.50
Soap Bucket	GMP 7271	2	8.00
Solder Set	9Q3433-00-889-1796	3	27.66
Tape, Semi-Con # 13	5970-00-441-8629	68	1.80
Tape, Hi.Volt. Rub. 23	5970-00-931-4491	487	1.73
Tape, Shielding #24	3M, PLM	262	3.00
Tape, Glass ½" X 180', #27	5970-00-543-1154	8	1.37
Tape, Glass 1" X 180'	5970-00-686-9151	8	4.07
Tape, Plastic, 33+	5970-00-788-4901	44	1.14
Tape, Silicone Rubber # 70	5970-00-840-8454	15	5.88
Tape, Plastic, 3/4" Ply	5970-00-419-4291	44	.94
Tape, Vinyl, 1" #88, 108'	5970-00-419-3164	30	1.07
Tape, Plastic 1½" X 108'	5970-00-150-2009	15	1.88
Tape, Vinyl, Mastic, Roll 4" X 10'	3M #2210	1	6.20
Tape, Varnished Cambric, 3/4"	3M #2510	223	1.95
Tape, Scotchfill	5970-00-045-3699	15	1.54
Tape, Fibermat, III, ½"	3M #2551	120	1.40
Tape, Fibermat, III, ½" Oil Immersed	3M #2551	130	1.54

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Tape, Fibermat, III, 3/4"	3M #2551	225	1.55
Oil Stop	3M, Irvington 621	30	1.23
Resin, "Scotchcast" #4-B	5970-00-682-8999	15	3.24
Resin, "Scotchcast" #4/C	5970-00-814-1788	75	6.04
Elect. Abrasive Grit, 80	5350-00-187-6284	3	4.84
Elect. Abrasive Grit, 320	5350-00-187-6289	1	5.66
Injection Fitting, P-1	5175-00-992-3589	15	.36
Nozzle, P-5	5175-00-992-3590	75	.24
Tape, Spacer, P3	5975-00-909-2053	105	2.52
Tape, Restricting, P4	5975-00-574-8117	100	1.70
Glyptal, ½Pint	5970-00-900-9372	30	.59
"Scotch Kote"	5970-00-962-3335	10	1.66
"K" Termination Kit	5940-00-578-0956	5	15.70
Splice Kit, 82-A2	5970-00-810-1512	15	4.10
Comm. Cable Capping Kit	3M #3820	15	1.51
Splice Kit, 89D2	5975-00-657-1544	15	6.38
Tape Aluminum, 4" X 20', #49	7510-00-071-6854	1	4.80
Tape Aluminum, 2" X 20', #49	3M #	1	2.60
Splice Kit, Power	Tomic BW-301A	15	14.25
Term. Kit, Power	Tomic PSR-13	5	16.50
Tape, Friction, 3/4"	5970-00-644-3167	23	.56
Paste, "Pentrox"	5975-00-905-8075	1	2.20
Flux, Stick f/Copper	GE 1533 A10A3	5	.35

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Stearin Candle	General Machine Products GMP-4320	40	.26
Solder 50/50	3439-00-163-4347	75	3.26
Solder 40/60	3439-00-247-6921	150	2.30
Solder, SN 50, Wire Roll	3439-00-273-1637	4	12.41
Rags, Wiping	7920-00-205-3590	2	43.00
Paraffin, lb	GMP/A.E.	20	1.50
Flux, Soldering	3439-00-255-4571	4	.21
Tape, Textile ½"	GMP 6684-A	30	.90
Tape, Cotton	GMP-6684B	30	1.25
Tape, Pasters, Gummed, 2"x60'	8135-00-908-0547 GMP-6865	30	.60
Muslin, 4" X 10 yds	GMP-6727-4	8	.85
Sleeves, Cotton 1/8	5970-00-189-5911 GMP-6436-B	1	1.30
Sleeves, Cotton 5/32	5970-00-189-5912 GMP-6436-C	8	1.37
Sleeves, Cotton 1/4"	5970-00-189-5913 GMP-6436-D	3	2.72
Sleeves, Cotton 1/4"	5970-00-189-5900	3	.65
Sleeves, Filled, Plastic, .085 Yellow	5970-00-821-6666	10	.03
Sleeves, Filled, Plastic, .105 Green	5970-00-344-3111	1	2.30
Sleeves, Filled, Plastic, .145 Red	5970-00-089-4493	10	.04

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Sleeves, Filled, Plastic .125 Clear	5970-00-089-4495	10	.03
Sleeves, Filled, Plastic .165 Blue	5970-00-089-4494	10	.04
Connector, Tele "B", AT-7759(WE CO. "B"	5940-00-949-4008	1200	.05
Sleeve, Plastic, .106 Yellow	General Machine Products GMP 7574-Y	.5	1.45
Sleeve, Plastic, .133 Red	GMP 7574-R	.5	1.60
Sleeve, Plastic, .166 Blk	GMP 7574-BLK	.5	1.75
Splice, "Pick-A-Bond, Red AWG 24-19	5940-00-177-2630	750	.06
Splice, "Pick-A-Bond, Grn AWG 26-22	5940-00-177-2628	750	.06
Cable, Telephone, 26 PR., PILC, 22 GA.	6145-00-223-4782	135	.56
Cable, Telephone, 51 PR., PILC, 22 GA.	6145-00-220-9925	225	.67
Cable, Telephone, 101 PR., PILC, 22 GA.	6145-00-220-9926	90	1.25
Cable, Telephone, 25 PR., PIC, 22 GA.	6145-00-577-8064	135	.37
Cable, Telephone, 50 PR., PIC, 22 GA.	6145-00-577-8072	135	1.28
Cable, Telephone, 100 PR., PIC, 22 GA.	6145-00-577-8081	90	1.61
Cable, Telephone, 200 PR., PIC, 26 GA.	6145-00-683-0813	90	1.21

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Cable, Telephone, 25 PR., Figure "8", 19 GA.	6145-00-781-6717	90	.51
Cable, Telephone, 50 PR., Figure "8", 22 GA.	6145-00-999-3431	90	.97
Cable, Power, #8 AWG, 1/C, RR, 5 K.V.	PC 880	90	.31
Cable, Power, 4/0 AWG, 1/C, RL, 5 K.V.	MEC PC 713	225	2.16
Cable, Power, 4/0 AWG, 1/C, XLP, 5 K.V., S.	MEC PC 2317	180	2.50
Cable, Power, 4/0 AWG, 3/C, XLP, 5 K.V., Shielded	MEC PC 2417	90	8.40
Cable, Power, 4/0 AWG, 1/C, XLP, 15 K.V., Shielded, Grnd.	MEC PC 2670	135	2.65
Cable, Power, 4/0 AWG, 1/C, XLP, 15 K.V., Shielded, UNGRND.	PC 2691	400	3.16
Cable, Power, 2/0 AWG, 3/C, XLP, 15 K.V., Shielded, Grnd., w/Neutral	MEC PC 2455	150	5.50
Cable, Power, 250 MCM, 3/C, XLP, 15 K.V., without Neutral Shielded Grnd.	MEC PC 2458	300	8.75
CABLE, Power, 500 MCM, 1/C, EPR, 15 K.V., Compact, Unishield	PC 3481	100	No Cost Excess
Cable, Power, 500 MCM, 1/C, EPR, 15 K.V., Concentric Shielded	PC 1770	90	No Cost Excess

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Cable, Power, #2 AWG, 1/C, EPR, 29 K.V., Shielded, Grnd.	MEC PC 1700	90	No Cost Excess
Cable, Power, #1/0 AWG, 1/C, XLP, URD, Aluminum, 15 K.V.	MEC PC 3622	100	.47
Cable, Power, #1 AWG, 1/C, XLP, URD, Aluminum, 25 K.V.	MEC P2 3640	100	No Cost Excess
Cable, Power, 4/0 AWG 1/C, VCL 5 K.V.	MEC PC 4046	155	3.00
Cable, Power, 4/0 AWG 3/C, VCL 5 K.V.	MEC PC-4231	100	7.80
Cable, Power, 4/0 AWG 1/C, VCL 15 K.V., UNGRD	MEC PC-4189	300	3.60
Cable, Power, 2/0 AWG 3/C, PILC 15 K.V.	MEC PC 4408	100	No Cost Excess
Cable, Power, 4/0 AWG 3/C PILC 15 K.V.	MEC PC 4410	45	No Cost Excess
Connectors, "Scotchlock" UR	5940-00-988-6311	3	5.63
Connectors, "Scotchlock" UG	5940-00-070-9621	3	5.00
Connectors, "Scotchlock" UY	8060-11-0900-4 3M	7.5	5.50
Sleeving, Lead 1½" X 72"	5975-00-280-3384	3	8.77
Sleeving, Lead 1 3/4" X 120"	5975-00-993-6089	3	23.50
Sleeving, Lead 2" X 72"	5975-00-509-2462	2.5	12.40
Sleeving, Lead 2½" X 72"	5975-00-509-2463	2.5	18.70
Sleeving, Lead 3" X 120"	5975-00-393-2095	2	59.00
Sleeving, Lead 3½" X 120"	5975-00-393-2096	.5	32.00
Sleeving, Lead 4" X 120"	5975-00-393-2097	3	50.90

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Connector, AWG 8, T&B 54504	5940-180-7953	30	.37
Connector, AWG 2, T&B 54507		15	1.00
Connector, AWG 2	Burndy YSIC	15	1.00
Connector, AWG 1/0, Aluminum	Burndy YS-25-A	15	1.16
Connector, AWG 2/0, Solder	Richards, Cat. #10	45	.84
Connector, AWG 4/0, Solder	Richards, Cat. #12	90	1.13
Connector, AWG 250 4/0, Solder	Richards, Cat. R-13	15	3.89
Connector, AWG 4/0 - 2/0, Solder	Richards, Cat. R-12	45	3.20
Connector, AWG 4/0 - 4/0 - 4-0	Richards, Cat.	15	4.08
Connector, AWG "Tee" 4/o	Richards, Cat. T-12	15	5.15
Connector, AWG, 4/0 Crimp	5940-00-258-5899	60	1.61
Terminal, Crimp, 4/0	5940-00-841-3783	15	1.66
Terminal, Crimp, 2/0	5940-00-087-0887	15	.68
Connector, AWG 500	ILSCO CTL-500	15	2.88
Terminal, Crimp 500	ILSCO CRA-500	15	2.88
Live End Cap #1	Insulation Mfg. Co.	15	8.25
Live End Cap #2	Insulation Mfg. Co.	15	8.25
Steel Tool Box	A.E. # S571380	1	15.58
Fiber Test Board	A.E. # S571330	2	.72
Shave Hook	General Machine Products GMP-7151	1	3.96

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Scratch Awl	5120-00221-1542	1	.80
Electricians Scissors	5110-00754-1499	1	2.21
Cleaner, File, Combination	7920-00224-7987	1	1.34
Folding Rule, 6'	5210-00293-3511	1	1.90
Cable Splicers Mirror	5120-00892-5709	1	.89
Screwdriver, 6" X 5/16"	5120-00764-8059	1	.84
Lineman's Pliers 8"	5120-00756-1156	1	2.58
Diagonal Pliers 6"	5110-00239-8253	1	2.68
Calipers, Outside General	5210-00229-3048	1	2.97
Knife, Taper	5110-00268-3882	1	.39
Knife, Straight, Shoe	5110-00595-8403	1	.38
Knife, Cable Sheath, (small)	5110-00596-1093	1	6.08
Knife, Cable Sheath, (large)	J. Stortz & Son	1	3.84
Wooden Cable Dresser	GMP 46-L-113	1	11.50
Pouring Ladles, 3/4 pint	GMP 6085	2	6.50
Wiping Cloth 2" X 2"	A.E. # S5720222	1	1.00
Wiping Cloth 3" X 3"	3439-00576-0897	1	1.38
Wiping Cloth 4" X 4"	A. E. # S572026	1	1.02
Flat Catch Cloth, 6" X 6"	9G3439-00576-0896	1	1.85
Flat Catch Cloth, 8" X 8"	3439-00408-0337	1	1.19
Safety Goggles	4240-00052-3776	1	.71
Tinners Hammer	5120-00236-3722	1	3.37

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Handle and Rasp, 12"	5110-00233-9712	1	2.91
File, Flat Bastard 12"	5110-00242-5386	1	1.76
Temperometer	A.E. # S578725	1	16.67
"B" Cable Sheath Opener	GMP - 7274	1	3.00
Long Wristlet Cotten Gloves	David Gloves	1	.57
Work Gloves, Cotten	8415-00268-8330	1	1.04
Wooden Separator		2	
Pliers, Combination, 8"	5120-00223-7397	1	1.29
Wrench, Adj., 8"	5120-00240-5328	1	1.92
"B" Connector Pressure Tool	5120-00939-6185	1	35.00
Scotchlok Cartridge Tool	E9C	1	40.00
Scotchlok Crimping Tool	3M Co. "E9" Tool	1	9.15
Wrench Telescoping	5120-00868-0831	1	2.18
Cable Stripper Jones 2 Way	9Q5110-00-238-7696	1	38.48
Tabbing Shear	GMP No. 7669	1	12.00
Stripper 22 AWG, GA.	AE-S-578419	1	3.28
VS-3 Pick-A-Bond Tool Crimping Tool	5120-00-421-0435	1	2.30
Tool Holder Adapter	5120-00-421-0451	1	3.45
Leadwedges,	5975-00-908-9478 GMP 6783-1	15	.38
Leadwedges	5975-00-534-8756 GMP 6783-2	30	.55

ANNEX I - EQUIPMENT (continued)

Type Designator & Nomenclature	National Stock Number	Quantity Required	Per Item Cost
Leadwedges	5975-00-408-4460 GMP 6783-3	15	.58
Leadwedges	5975-00-356-4943 GMP 6783-4	15	.86
Splice Closure 1A1	5805-00-835-0134	15	25.29
Splice Closure 1B1	5805-00-835-0143	15	14.70
Splice Closure 49A2	5805-00-084-0202	15	8.28
Splice Closure 49B2	5805-00-084-0200	15	5.90
Buried Tele Closure	3M BB/2SC 2"	15	9.71
Tele Shield Connector	3M 4461	30	.75
VS-3 Tool Holder	5120-00-350-3716	15	14.46

ANNEX I - TRAINING AIDS

Film

TF 6[illegible]	COMMUNICATIONS CABLE	1 ea.
TF 6178B	COMMUNICATIONS CABLE, SPLICING	1 ea.
TF 6178C	COMMUNICATIONS CABLE, SEALING	1 ea.
ME-5472	SUPERVISING WORKERS ON THE JOB	1 ea.
MN-3425E	SUPERVISION/CREATING JOB INTEREST	1 ea.
ME-5213A	PROBLEMS IN SUPERVISION-THE SUPERVISOR AS A LEADER	1 ea.
ME-5471	PLACING THE RIGHT MAN ON THE JOB	1 ea.
#28	WIRE FOR SOUND	1 ea.
#38	FAR SOUND	1 ea.

Slides

35 mm	Sequence of 1 Way-3 Way Joint
35 mm	All-tape and "Scotchcast" Type Material, 3M Products

Assignment Sheets

1.1.5.1A	Operation Of Basic Mathematics

Information Sheets

1.1.1.1I	Command Policies
1.1.3.1I	General Safety Precautions and First Aid
1.2.1.1I	Terms and Definitions
1.2.1.2I	Telephone Cable Identification
1.2.2.1I	Color Codes

ANNEX I - TRAINING AIDS (Continued)

Information Sheets (Continued)

1.2.3.1I	Desiccant
1.3.1.1I	Types of Power Cable
1.3.8.1I	Aluminum Cable and Splices
1.4.1.1I	Tools, Materials and Equipment

Job Sheets

1.2.1.1J	Straight Splice, Lead
1.2.1.2J	Bridge Splice, Lead
1.2.1.3J	Butt Splice, Lead
1.2.21.J	Straight Splice, Plastic
1.2.2.2J	Bridge Splice, Plastic
1.2.2.3J	Butt Splice, Plastic
1.2.3.1J	Joining Plastic and Lead Sheathed Telephone Cable
1.3.1.1J	5 kv (5000 volts) "Scotchcast" 82-Series Splicing Kit Instructions
1.3.2.1J	5 kv Rubber Insulated-Lead Covered Joint Construction
1.3.3.1J	5 kv Single Conductor Capnut Pothead
1.3.4.1J	Manufacturers Splice - Kit (All-Tape) Instructions
1.3.4.2J	3M "Scotchcast" Print E-MPD-3
1.3.4.3J	"Collyer" Print No. SR-4: Mine Power Cable 5-15 kv, Straight Splice (Shielded), 3/C
1.3.5.1J	Scotch "K" Tape Termination Kits
1.3.6.1J	Straight Transition Splice W/Oil Stop, 5 kv, 1/C, XLP to VCL
1.3.7.1J	15 kv, Single Conductor, VCL Cable, Grounded, Branch Splice

ANNEX I - TRAINING AIDS (continued)

Job Sheets (continued)

1.3.8.1J	Straight Splice, 15 kv, XLP, URD-Aluminum
1.3.9.1J	15 kv Termination (All-Tape), Outdoor With Rainshield
1.3.10.1J	One Way-Three Way Joint, Three Conductor PILC to Three Single Conductor XLP Power Cable
1.3.11.1J	Pulling-Eye Attachment
1.3.12.1J	Live End Cap For 15 kv Varnished-Cambric Insulated-Lead Covered Power Cable

ANNEX II - TEXT MATERIALS

MILITARY PUBLICATION NUMBER (MILPUBS)	COMPLETE TITLE
NAVFAC P-405	Seabee Planner's and Estimator's Handbook
NAVPERS 10636-G	Construction Electrician 3 & 2
NAVPERS 10637-D	Construction Electrician 1 & C
TM 11-372-1	Splicing Cable (Outside Plant) Standard Installation Practices
TM 11-372-2	Splicing Telephone Cable, Setting Up Cable
TM 11-372-5	Standard Installation Practices Outside Plant Cable Pressurization
TM 11-372-6	Telephone Cable Splicing: Cable Testing
T.O. 31W3-10-15	Outside Plant - Cable Testing
AUTHOR (COMMERCIAL OR CIVILIAN PUBS)	COMPLETE TITLE, PUBLISHING COMPANY, EDITION, DATE
	Design and Engineering Manual, 3M Electro-Products Division
Thomas F. Staton	How To Study, 5th Edition, P.O. Box 6133, Montgomery, AL 36106
	Terminations and Splices - Theory-Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio
Editorial Staff	Underground Systems Reference Book, 1957 Edition, Edison Electric Institute

ANNEX II - REFERENCES

MILITARY PUBLICATIONS

NUMBER (MILPUBS)	COMPLETE TITLE
NAVMATP-5100	Safety Precautions For Shore Activities
NAVPERS 16808-B	Constructing and Using Achievement Tests
NAVPERS 94415	General Mathematics For Construction Rating
NAVPERS 94417	Applied Mathematics For Construction Electricians
TM 11-372-7	Telephone Cable Splicing, Terminations and Cable Repair

AUTHOR (COMMERCIAL OR CIVILIAN PUBS)	COMPLETE TITLE, PUBLISHING COMPANY, EDITION, DATE
	Cable Splicing Handbook 2, 1972, AT&T Company
	First Aid Textbook, Fourth Edition, American Red Cross
	The Rome Cable Manual of Technical Information, 2nd Edition, 1957, Rome Cable Corporation, Rome, N. Y. (Now, Cyprus Wire and Cable Company)
	UD Technical Manual, Cyprus Wire and Cable Company

FOR OFFICIAL USE ONLY

INSTRUCTOR'S GUIDE
FOR
CONSTRUCTION ELECTRICIANS/POWER & COMMUNICATIONS CABLE SPLICING

CLASS C1 A-721-0023

PREPARED BY

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

PREPARED FOR

CHIEF OF NAVAL TECHNICAL TRAINING
MILLINGTON, TENNESSEE 38054

DATE

23 FEBRUARY 1977

TABLE OF CONTENTS

FRONT MATTER

PAGE

Table of Contents- - - - ii

Safety Notice- - - - iv

How To Use The Instructor's Guide- - - - v

LESSON TOPIC GUIDES

1.1.3 SAFETY POLICIES - - - - 1.1.3-1

1.2.1 LEAD SHEATHED CABLE JOINTS- - - - 1.2.1-1

1.2.2 PLASTIC SHEATHED CABLE JOINTS - - - - 1.2.2-1

1.2.3 JOIN PLASTIC AND LEAD SHEATHED CABLE- - - - 1.2.3-1

1.3.1 STRAIGHT SPLICE, 5 KV, RR, AWG #8 - - - - 1.3.1-1

1.3.2 STRAIGHT AND BRANCH SPLICES, 5 KV, R-L, AWG #4/0- - - - 1.3.2-1

NOTE: LESSON GUIDES 1.1.1, 1.1.2, 1.1.4, 1.1.5 HAVE BEEN DELETED DUE TO MILITARY SPECIFIC MATERIAL.

PAGE

LESSON TOPIC GUIDES (CONTINUED)

1.3.3 TERMINATION SPLICE, 5 KV, VARNISHED CAMBRIC INSULATED-LEAD SHEATHED AWG #4/0 POWER CABLE - 1.3.3-1

1.3.4 CROSS-LINKED POLYETHLENE INSULATED CABLE SPLICING - - - - - - - - - - - - - - - - - - 1.3.4-1

1.3.5 TERMINATIONS WITH XLP 5 KV CABLE- 1.3.5-1

1.3.6 STRAIGHT TRANSITION SPLICE W/OIL STOP, 5KV, 1/C, XLP TO VCL - - - - - - - - - - - - - 1.3.6-1

1.3.7 BRANCH SPLICE, 15 KV, VCL, AWG #4/0 - 1.3.7-1

1.3.8 STRAIGHT SPLICE, 15 KV, XLP, URD-ALUMINUM - 1.3.8-1

1.3.9 TERMINATION (ALL-TAPE), OUTDOOR W/RAINSHIELD, 15 KV, XLP INSULATED, AWG #2/0, 3/C- 1.3.9-1

1.3.10 TRIFURCATION/TRANSITION 1 WAY-3 WAY, 15 KV, THREE 1/C CROSS-LINKED POLYETHLENE, SHIELDED TO A PAPER INSULATED-LEAD SHEATHED 3/C, POWER CABLE - 1.3.10-1

1.3.11 PULLING-EYE ATTACHMENT ON A 5 KV RUBBER-LEAD, 1/C POWER CABLE - - - - - - - - - - - 1.3.11-1

1.3.12 LIVE END CAP ON A 15 KV, 1/C, VARNISHED-CAMBRIC INSULATED-LEAD COVERED POWER CABLE - 1.3.12-1

SAFETY NOTICE

CABLE

1. Electrical Power cable is not to be used to support chain falls, lifting tackle, or weights of any kind.
2. Scaling, chipping, and wire brushing shall not be performed on power or lighting cable.
3. Power cable is not to be used as ladder rungs for climbing.
4. Work on power, lighting or telephone circuits shall not be performed by other than authorized and qualified personnel.
5. All electrical conductors shall be considered to be carrying current until it has been established beyond doubt that they are dead.

HANDLING HOT SOLDER AND COMPOUNDS

1. Keep furnaces far enough from manhole openings that there will be no possibility of hot metal or compound spilling into the manhole.
2. Never place a cold or wet ladle or other object in molten solder or hot compound.
3. Stand clear when solder and compound are being raised or lowered.
4. Work from above or to one side while soldering.
5. Do not breathe fumes more than necessary.
6. Wear goggles when soldering large joints and tinning lugs and T connections.
7. Do not leave the area of the kettle when heating solder or compounds.

HOW TO USE THIS INSTRUCTOR'S GUIDE

This Instructor's Guide has been prepared for your use while assigned duties as the instructor for the Construction Electricians/Power and Communications Cable Splicing course. Ample space has been provided for any notes you may wish to make that will help you in the conduct of the course. The lesson topic guides contained in this Instructor's Guide are grouped in units and provide you with the outline of instruction for each lesson topic of this course. The two-column Lesson Topic pages and the three-column Outline of Instruction/Instructor Activity/Student Activity pages printed in a horizontal format are developed in sufficient depth to be used as your primary teaching document. No further guide or lesson plan is required. As mentioned, this Instructor's Guide may be personalized by annotation or by the insertion of additional pages if required. This Instructor's Guide was developed from the approved Curriculum Outline for this course and the numbering system is consistent with that utilized in the Curriculum Outline. The outline of instruction is sequenced in the same order in which the learning objectives are listed. When information is not needed in the Instructor Activity or Student Activity columns, information normally printed under the Outline of Instruction column has been printed across the entire page for the purpose of economy.

The two-column Lesson Topic pages contain information that will assist you in preparing yourself for the conduct of instruction in this course. Found therein is the security classification of the lesson topic, the time allotment in contact hours, the listing of all instructional materials for the lesson topic, the objectives as contained in the Curriculum Outline from which this Instructor's Guide was developed, the criterion tests required, and the homework assignments that enhance the student achievement of objectives.

The three-column Outline of Instruction/Instructor Activity/Student Activity pages contain the outline of instruction developed in sufficient depth to be used as the instructor's primary teaching document during the conduct of the instruction, accompanied by the related instructor and student activities that enhance the learning process.

The left-hand column titled "Outline of Instruction" contains the major points to be covered during the lesson topic in full textbook narrative form, or descriptive phrases, or key words as appropriate outlining concepts, theories, descriptions, processes, procedures, etc., that make up the subject matter of the lesson topic.

The center column, titled "Instructor Activity" points out the activities which the instructor must carry out during the lesson topic in addition to oral discussion or lecture. In this column are such instructor activities as the projection of specific transparencies, films, slides, etc., the use of charts, wall charts, models, mockups, simulators, demonstrators, etc. and other training aids, devices, materials, etc. These activities are keyed therein to guide you through their use and application as invaluable aids to the teaching/learning process.

The right-hand column, titled "Student Activity" points out those student activities which may not be obvious to the instructor, but will help the student during the acquisition and application phases of the learning process. Activity specified under the "Student Activities" column contributes directly to his achievement of the objectives and development of his ability to do practical work. Items providing guidance include keying the use of the Student's Guide, general and specific directions for classroom, laboratory, workshop time, notes emphasizing observance of personnel and equipment safety precautions and security procedures to be adhered to. Using this Instructor's Guide ensures adherence to the approved plan of instruction for this course and alleviates the tedious chore of rewriting material already contained in the outline of instruction, you merely have to provide your own personalization to the Instructor's Guide in the space provided and your materials will be ready for your professional job of instruction.

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.1.3 SAFETY POLICIES

TIME ALLOCATION: Classroom 1 Hour
Practical 0 Hours

INSTRUCTIONAL MATERIALS:

1. Text: None
2. Reference:
   a. Safety Precautions for Shore Activities, NAVMATP-5100, January 1973
   b. First Aid Textbook, Fourth Edition, American Red Cross
3. Training Aids:
   a. General Safety Precautions and First Aid 1.1.3.1I (Locally prepared)
4. Training Aids Equipment: None
5. Tools and Equipment: None
6. Material: None

TERMINAL OBJECTIVE

Supported partially by this lesson topic:

#1.1 Upon completion of this unit, the student will have registered for the course, received text books, answered questions pertaining to key points of organization, mission, and regulations of Construction Training Center and the Construction Battalion Center as they may apply to him while a student in this course. He will also state how to report an accident or fire and list school safety practices.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.1.3 Upon completion of this topic, the student will demonstrate his ability to answer specific oral or written questions regarding key policies governing the safe handling of equipment and materials, consideration for personal safety (including avoiding and eliminating fire hazards); methods of reporting accidents and fires; and, duties and responsibilities of the Class Safety Petty Officer.

CRITERION TEST

The student will answer specific oral or written questions regarding key policies governing the safe handling of equipment and materials, consideration

8

for personal safety (including avoiding and eliminating fire hazards); methods of reporting accidents and fires; and, duties and responsibilities of the Class Safety Petty Officer. Failure to meet this objective is not considered disqualifying.

Homework - None

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish contact	Introduce self and topic	
B. Establish readiness	Direct student thinking along desired line	
C. Establish effect	Show the student the value of the subject matter to him	
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise How? When?	
II. Presentation	Hand out instructional material	
A. Safety responsibilities		
1. Command officers		
a. Ensures all personnel are instructed and drilled in all applicable safety precautions and procedures		
b. That they are complied with		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. That safety precautions, or extracts therefrom, are posted in appropriate places		
d. He shall issue or augment such safety precautions as he deems necessary, notifying higher authorities concerned when appropriate		
2. Supervisory personnel		
a. Ensure that their subordinates are instructed in and carry out safety precautions for their work and work area		
3. Individuals		
a. Responsible for:		
(1) Knowing		
(2) Understanding		
(3) Observing		
All safety precautions in his work and work area		
b. He is also responsible for the following:		

(

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVI

(1) Reporting for work rested and emotionally prepared for the tasks at hand

(2) He shall use normal prudence in all his functions, commensurate with the work at hand

(3) He shall report any unsafe conditions, equipment, or material

(4) He shall warn others who are endangered by hazards or fail to observe safety precautions

(5) He shall report to his supervisor:

  (a) Any accident

  (b) Any injury

  (c) Any evidence of impaired health during the work day

(6) He shall wear or use protective clothing and/or equipment

(7) He shall report for work suitably clothed for assigned task:

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

- (a) Suitable for trade or profession
- (b) Hair styles and beards
- (c) Safety shoes or foot protection devices
- (d) Jewelry, loose scarfs and ties
- (e) Individuals requiring eye correction, hearing aid or prosthetic devices

B. Electrical shock and first aid

1. Why deaths due to electrical shock
    - a. Not observing safety precautions
    - b. Carelessness
    - c. 115 volts or low voltage biggest killer
2. Conditions needed to cause shock
    - a. Person must be part of a closed circuit for current to flow
    - b. This circuit must contain a difference in potential or as commonly known - voltage

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

3. Factors determining severity of shock
    a. 0.001 ampere or 1 ma (one thousandth of an ampere) - felt
    b. 0.01 ampere or 1 ca (one hundredth of an ampere) - loss of muscle control
    c. 0.1 ampere or 1 da (one tenth of an ampere) - if 1 second or more - FATAL
4. Effect of body resistance
    a. Thick skin - 100,000 ohms per square centimeter area
    b. Thin skin - 10,000 ohms per square centimeter area
    c. Wet skin - varies 300 to 1,200 ohms per square centimeter area
5. Potential difference (voltage)
    a. 30 to 450 volts most dangerous

OUTLINE OF INSTRUCTION INSTRUCTOR ACTIVITY STUDENT ACTIVITY

b. 50% of all fatal accidents by electricity caused by 120 volts or less

6. Recognizing shock victims

a. Shock occurs when blood circulation is disturbed

b. Shock symptoms

(1) Skin - pale, cold, and moist

(2) Eyes - Vacant, lack luster and dilated pupils

(3) Breathing - shallow and irregular

(4) Pulse weak and rapid

(5) Muscle spasms

7. Removal of victim from source of electricity

a. Deenergize electrical circuit

CAUTION: Take care not to come in contact with source.

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

b. If unable to deenergize circuit quickly, pull victim off using any non-conducting material

(1) Belt

(2) Board

(3) Rope

8. After removal of victim

a. If still breathing, keep him lying down and warm

b. Loosen clothing to allow for free breathing

CAUTION: DO NOT give stimulants

c. If any serious bleeding, it must be checked prior to administering further first aid

d. If person is not breathing administer artificial respiration

e. Mouth to mouth resuscitation is the proper method to use

f. It should be started as soon as possible

g. Rate is about 12 breaths per minute

h. If victim's heart beat has stopped, apply closed chest cardiac massage

i. Proper application of cardiac massage

(1) Place subject on his back on a firm surface

(2) Kneel beside subject and place one hand across the breastbone with the heel of the hand resting on the sternum

NOTE: Sternum (definition) - Chest breastbone - a compound verntral bone or cartilage connecting the ribs and shoulder girdle

(3) Place second hand on top of first with fingers pointing toward the neck

(4) Rock forward with arms nearly straight so as to transmit your body weight through the arms

(5) Depress chest just enough to establish a pulse

(6) Repeat 60 to 80 times per minute

(7) Precautions:

(a) Insure proper hand position to prevent internal injuries

(b) Apply mouth to mouth resuscitation while massaging the heart

(c) If only one operator, interrupt massage every 30 seconds to apply resuscitation for 3 or 4 cycles

C. Safety precautions concerning fires

1. Fire prevention

a. General cleanliness of entire area

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

b. In work area where work with electricity is being done

   (1) Avoid use of flammable cleaning fluids

   (2) Gasoline, benzene, ether, and similar flammable cleaning fluids shall never be used on either energized or deenergized electrical apparatus

   (3) Alcohol shall never be used for cleaning near electrical equipment

c. Keep machinery clean

   (1) Oil, grease, carbon dust, etc.

   (2) Clean and inspect machinery

d. Cleaning fluids and open flames

   (1) Avoid open flames

   (2) Never use in confined spaces

   (3) Danger of explosions and fire

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

D. Fighting and reporting fires

1. Procedures to follow in case of fire

   a. Deenergize electrical circuits or equipment

   b. Give the alarm

   c. Evacuate the area

   d. Call the Fire Department

      (1) Fire Department may be called first if it is more expeditious than deenergizing power control circuit

      (2) Power circuits should be deenergized before fighting begins

   e. Control fire with correct type of firefighting equipment until fire department personnel arrive

   f. When notifying Fire Department:

      (1) Phone: Ext. 2333

      (2) Give building number and/or location of fire

OUTLINE OF INSTRUCTION INSTRUCTOR ACTIVITY STUDENT ACTIVITY

2. Classification of fires

   a. Class A - Those involving ordinary combustibles such as:

      (1) Wood

      (2) Cloth

      (3) Paper, etc.

   b. Class B - Those involving greases, oils, paints, other flammable petroleum products and flammable liquids in general

   c. Class C - Those involving energized electrical equipment

   d. Class D - Those involving combustible metals

E. Construction job safety

1. Drinking water

   a. Fresh and pure drinking water at every job site

   b. Obtained only from approved sources

OUTLINE OF INSTRUCTION INSTRUCTOR ACTIVITY STUDENT ACTIVITY

c. Use the following dispensing methods

(1) Stationary bubbler with guarded orifice installed on approved water line

(2) Enclosed water container and individual drinking cups

(3) Portable sanitary drinking fountain which meets Federal Specifications

d. Drinking water items prohibited

(1) Dipping water out by individual cup

(2) Individual canteen

(3) Or other utensil

e. Drinking water containers shall be thoroughly sterilized at least once a week or more frequently if required

2. Temporary toilet facilities

a. Number required. For every 30 persons or less, a privy or closet space shall be provided.

b. Privacy. Shall be constructed to shield occupant from view and protect against weather and falling objects

c. Location. Located so as not to contaminate any domestic water supply used for drinking purposes

d. Drainage. So located and banked that surface water cannot flood the pit

e. Trough. Each privy provided with adequate urinal trough

f. Sewer connections. If available, connections shall be made at once

g. Pit latrines. If no other facilities available, a pit latrine may be constructed.

(1) Shall contain fly-tight box

(2) Constructed over a pit or pail

(3) Or other suitable containers where pits are impracticable

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

3. Personal protection
    a. Clothing and equipment
        (1) According to type of work
        (2) Chipper's goggles
        (3) Welder's goggles
        (4) Welder's shields
        (5) Hard hats
        (6) Safety shoes
        (7) Rubber boots
        (8) Safety belts
        (9) Lifelines
        (10) Life nets
        (11) Life preservers or jackets
        (12) Respirators
        (13) Other such protective equipment or clothing
4. Electric wiring and equipment

a. Temporary electrical wiring

(1) Installed and maintained by competent and qualified workmen

(2) Installed to protect all persons against injury

NOTE: Temporary and permanent electrical installations should be in accordance with the National Electrical Code.

b. Grounding equipment. Electrical equipment shall be grounded in accordance with the National Electrical Code

c. Insulation mats

(1) Suitable insulating mats or platforms

(2) Provides good footing for operator or persons in the vicinity of electrical machines or equipment having exposed live parts of more than 30 volts

(3) Individual cannot readily touch such parts unless standing on these mats or platforms

d. Extension cords

(1) Construction sites - Ground fault circuit interrupters are required for all temporary 120-volt, single phase, 15 and 20 ampere receptacle outlets.

(2) Flexible cords and cables and their associated fittings shall be suitable for the conditions of use and location and should be of superior quality.

(3) Shall be tested and inspected on a regular basis and maintained in a safe condition.

(4) Shall be kept dry and free from oil or grease.

F. How to prevent accidents

1. Good work habits
2. Housekeeping
3. Safety equipment

4. Safety policy
    a. Equipment and material
        (1) Proper use
        (2) Proper inspections
        (3) Proper storage

G. Reporting accidents

1. Report all accidents no matter how minor
2. Victim will be sent to the Dispensary/Hospital for treatment
3. Instructor/supervisor will fill out required accident forms
    a. Accidental Injury/Death Report, OPNAV Form 5100/1
    b. Submit report to Department Safety Supervisor

H. Duties of Class Safety Petty Officer

1. Aid instructor in enforcing safety policies

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Aid instructor in reporting accidents		
3. Ensure proper personnel protective gear is worn by individuals for working conditions involved in		
a. Hardhat		
b. Ear plugs		
c. Gloves		
d. Safety shoes		
e. Eye protection		
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
IV. Summary:	Review of important subject matter	Give undivided attention
A. Safety responsibilities	Do not introduce new material	
B. Electrical shock and first aid	Hold all questions until completion of summary	
C. Safety precautions concerning fires		
D. Fighting and reporting fires		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIV
E. Construction job safety		
F. How to prevent accidents		
G. Reporting accidents		
H. Duties of Class Safety Petty Officer		Ask questions after completion of summary.
V. Test: None Note: Failure to meet this topic objective is not considered disqualifying		
VI. Assignment: None		

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/
CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.2.1 LEAD SHEATHED CABLE JOINTS

TIME ALLOCATION: Classroom 2 Hours
Practical 30 Hours

INSTRUCTIONAL MATERIALS:

1. Text:

   a. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1

   b. Splicing Telephone Cable, Setting Up Cable, TM 11-372-2

   c. Standard Installation Practices Outside Plant Cable Pressurization, TM 11-372-5

   d. Telephone Cable Splicing: Cable Testing, TM 11-372-6

   e. Telephone Cable Splicing, Cable Terminations and Cable Repair, TM 11-372-7

   f. Construction Electrician 3 & 2, NAVPERS 10636-G

   g. Outside Plant - Cable Testing, USAF T.O. 31W3-10-15, dated 1 July 1970

2. Reference: None

3. Training Aids:

   a. Display board

      (1) Types of Lead Sheath Telephone Cable

      (2) Steps of the Straight Splice

      (3) Steps of the Bridge Splice

      (4) Steps of the Butt Splice

   b. Transparencies

      (1) Straight Splice

      (2) Bridge Splice

      (3) Butt Splice

   c. Film

      (1) Wire For Sound, W/E Company

      (2) Far Sound, W/E Company

   d. Terms and Definitions, CE "C" 1.2.1.1I
   e. Telephone Cable Identification, CE "C" 1.2.1.2I
   f. Straight Splice, Lead, CE "C" 1.2.1.1J
   g. Bridge Splice, Lead, CE "C" 1.2.1.2J
   h. Butt Splice, Lead, CE "C" 1.2.1.3J

4. Training Aids Equipment:
   a. Projector, Movie, 16 mm
   b. Projector, Overhead

5. Tools and Equipment:
   a. Cable Splicer's Tool Box
   b. Catch pan
   c. Solder pot
   d. Paraffin pot

6. Material:
   a. Lead Sheathed Telephone Cable, 26 pair, 19 to 22 AWG (10' per student)
   b. Lead Sheathed Telephone Cable, 26 to 51 pair, 19 to 22 AWG (10' per student)
   c. Lead Sheathed Telephone Cable, 101 pair, 19 to 22 AWG
   d. Sleeve, cotton, single wall, ¼" (16 to 19 AWG)
   e. Sleeve, Cotton, single wall, 5/8" (22 AWG)
   f. Sleeve, Cotton, single wall, 1/8" (24 AWG)
   g. Sleeve, Cotton, single wall, 3/32" (26 AWG)
   h. Sleeve, Plastic, Yellow, 19 AWG (Bridge)
   i. Sleeve, Plastic, Red, 19 AWG (Straight)
   j. Sleeve, Plastic, Red, 22 thru 24 AWG (Bridge)
   k. Sleeve, Plastic, Black, 22 AWG (Straight)
   l. Sleeve, Plastic, Green, 24 AWG (Straight)
   m. Sleeve, Plastic filled
   n. "B" Connector
   o. Connector Scotchlock or equivalent (UY 19 thru 26 AWG, solid)
   p. Sterine flux
   q. Paraffin

TERMINAL OBJECTIVE

Supported entirely by this lesson topic"

#1.2 Upon completion of this unit the student will be able to splice telephone cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

1. Lead sheathed telephone cable
   a. Straight splice - 7.0 hours
   b. Butt splice - 7.0 hours
   c. Bridge splice - 7.0 hours

All splices will be constructed in accordance with TM 11-372-series, Construction Electrician 3 & 2, NAVPERS 10636-G, and Job Sheets CE "C" 1.2J series; and will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.2.1 Upon completion of this topic the student will be able to construct a straight, butt and bridge splice in a lead sheathed telephone cable utilizing the appropriate tools and materials in accordance with TM 11-372-1, 2, 5, 6, and 7; and Construction Electrician 3 & 2, NAVPERS 10636-G; and Job Sheets CE "C" 1.2.1.1J, 1.2.1.2J, and 1.2.1.3J without deviation. All splices will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

CRITERION TEST

The student will construct a straight, butt, and bridge splice in a lead sheathed telephone cable utilizing the appropriate tools and materials in accordance with TM 11-372-1, 2, 5, 6, and 7; and Construction Electrician 3 & 2, NAVPERS 10636-G; and Job Sheets CE "C" 1.2.1.1J, 1.2.1.2J, and 1.2.1.3J without deviation. All splices will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

HOMEWORK

Read and study TM 11-372-1, chapters 1, 2, and 3

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him.	
D. Overview	State topic objective Explain the method(s) to be used. Topic Criterion Exercise: How? When?	
II. Presentation:	Make ready the T/A(s) listed for this lesson.	
A. Types of Splices to be Made		
1. Straight	Hand out text and Job Sheets for this lesson.	
2. Bridge		
3. Butt		
B. Applications of Telephone Cable		
1. Voice circuits		

2. Control circuits
3. Where used
    a. Aerial
    b. Direct burial
    c. Conduit
        (1) Usually found in larger cities and other places that putting it in the air would be hazardous
        (2) May be run from one manhole to another

C. Terms and Definitions Used In Telephone Cable Splicing

1. Inside plant - Houses all the equipment and cables used in a telephone system. (Also called the Central Office.)
2. Outside plant - All other cables and equipment that is located outside the central office.
3. Core - The conductors of a telephone cable.

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

4. Lead sheath - The lead covering the core

5. Crotch plug - Common term for lead wedge or crotch piece

6. Binder - Distinctively marked string found in unit-type cable. Used to tie conductors of a unit together.

7. Boarding - Operation of installing numbered pairs, quads, or conductors in a test board.

8. Boiling out - Operation of removing moisture by pouring molten paraffin over lead covered cable and splicing materials.

9. Building up the heat - Act of pouring molten solder onto the sheath until it is sufficiently heated for rough forming of a wiped sleeve splice finishing joint.

10. Choker - Protective cloth wrapping installed at sheath ends of splice opening. Used for butting of sheaths.

11. Cold Joint - Wiped sleeve which appears as though it has been wiped with cold solder. It has a rough surface and a chalky appearance.

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

12. Dressing - Operation of rounding and forming ends of lead sleeve by beating in with cable dresser.

13. Drying out - Operation to remove moisture by pouring desiccant (moisture absorbing powder) over cable and splicing materials.

14. Eutectic - Name for condition of maximum fusibility in a mixture.

    Example: Solder mixture of 37% lead and 63% tin is 100% eutectic because this mixture may be more easily melted than any other solder mixture.

15. Flux - Substance used to desolve the oxides which form on the surface of materials (metals) to be soldered. Sterine is the flux commonly used in splicing telephone cables.

16. Hillup - Operation to cause solder to form a mound near the center of a split lead sleeve.

17. Bead seal - A V-shaped seam made in a lead sleeve to form split lead sleeve's solder joint.

18. Running a seam - Operation to solder a split lead sleeve together.

19. Shim - Strip of cable sheath

20. Shiner - A bare spot in a conductor

    NOTE: It is caused by excessive exposure to moisture by lightning burns or excessive testing.

21. Tacking - Operation to use molten lead to temporarily hold or secure an object.

22. Tinning - Operation to initially coat with solder the object to be soldered. It is the first step in soldering an object.

23. Tin runs out - A term which denotes a finished wiped sleeve splice with improperly mixed solder.

D. Basic Geometric Patterns.

1. General information

    a. The basic geometric patterns are the layer and the unit.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

c. The number of arrangement of the layers and/or the units is determined by size (circuit count and gauge) of the cable.

d. It is the number of units or layers and their position with relation to the central office that determine the count which is the basis of conductor identification.

2. Layer

   a. When circuits (pairs, quads, and the like) are positioned to form a circle.

   b. Layers are of two types.

      (1) Simple Layer - The circuits are arranged in concentric circles and each concentric circle is one circuit thick

      (2) Color group - A group of adjacent layers considered as one

         (a) The circuits are arranged in concentric circles

(b) Each concentric circle is at least two circuits thick

(c) The connectors of each circuit are twisted together

(d) Adjacent layers have distinguishing color codes

(e) Layers may overlap

3. Unit

   a. Second basic geometric pattern

   b. The same gauge wire and direction of twist

   c. The number of circuits and gauge of the conductors in the cable determine the number of units

   d. In some cases the unit may consist of the entire core

   e. Or it may consist of only a section of the core

f. Single-unit cables have a maximum of 76 circuits

g. Multiple-unit cables have a minimum of 101 circuits

h. All units are of two types, uniform color units or mixed color unit

NOTE: Uniform color and mixed color are not furnished in combination within the same cable. There are many other types of multiple-unit cables.

4. Uniform color unit

   a. Circuits within each unit have insulation of two colors.

   b. For example, the insulation of all the pairs may be colored white-green.

   c. The unit is designated as a white-green unit.

   d. The insulation of one conductor of each pair of the unit is colored green, the other is colored white.

5. Mixed color unit

   a. Circuits of each unit have three colors of insulation.

   b. Circuits of each unit are arranged in layers which contain only two colors.

   c. The color of the outer layer of the unit is used as the designating color.

   d. For example, within a given unit of mixed color, paired cable, all the pairs are white - green, white - red, and white blue.

   e. White - blue is the color of the outer layer.

   f. The entire unit is designated as a white - blue unit.

E. Conductor

1. Cables contain various quantities of conductors.

2. The conductor provides the circuit.

3. Each conductor is of a definite gauge.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

4. To provide various types of circuits these conductors are arranged in groups of two conductors, four conductors, etc.

F. Insulation of Conductors

1. Tinned or untinned

2. Enameled insulated or lacquered

3. Standard types of insulation

   a. Strip paper

   b. Pulp paper

   c. Textile

   d. Plastic

   e. Rubber

4. Paper insulated is used only in sealed cable.

5. Tinning, enameling and lacquering are optional.

6. Tinning and enameling increase the insulation resistance of the conductor.

7. Lacquering eliminates the necessity of boiling out or drying when splicing.

UTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

G. Basic Counting Procedure

1. Three considerations

   a. Relative position of the central office and the cable end

   b. Geometric pattern

   c. Tracer pairs

2. Position of cable and central office

   a. Represent the end of the cable as the face of a clock

   b. If the end faces away from the central office, the count is made in a counter-clockwise direction.

   c. If the end faces toward the central office, the count is in a clockwise direction.

NOTE: If the cable terminates in two central offices, for example, as in the case of interoffice trunk cable, one of the central offices is selected as the reference office in determining the direction of the count.

3. Geometric pattern

   a. Once the pattern has been established the count theoretically begins at the center of the core and proceeds to the sheath in a clockwise or counter-clockwise direction.

   b. If a layer contains units of composite gauge.

      (1) The large gauge units receive the low count of the layer.

      (2) The small gauge units receive the high count of the layer.

4. Tracer pairs

   a. Always receives the highest count of the layer or unit.

   b. Located in the core.

   c. Contains distinctively colored circuits.

      (1) Known as tracer

      (2) Known as markers

   d. The tracers are used to provide talking circuits or spare circuits.

e. The markers are used to establish counts in unit-type cables.

H. Composite Cable

1. Part of the conductors are of two or more other gauges.

2. Conductors of each circuit are of the same gauge.

3. By gauge composite cables may be divided into two basic complements.

   a. One complement contains the circuits of one gauge.

   b. The other complement contains the circuits of the other gauge.

4. Composite cables are furnished with various complements arranged in layers, units, and layers of units.

5. Large gauge complement is usually located near or at the center of the core.

6. Small gauge complement is usually located away from center of the core.

I. Straight Splice, Lead

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

1. Preparing The Lead Sleeve
   a. Cut sleeve ends squarely
   b. Bevel edges of both ends
   c. Clean two areas, one at each end of the sleeve. This area will be wide enough to extend under the cable pasters to each end of the sleeve.
   d. Coat cleaned areas with sterine
   e. Beat down one end until it will just fit over the cable and slip it out of the way
2. Preparing The Lead Sheath Cable
   a. Avoid severe bending
   b. Allow for proper overlaping of cable ends
   c. Establish the center line of the splice
      (1) Minimum of 3' overlap
      (2) Center line should be set up so that it will be in the center of the complete splice.

LINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Splice-opening length depends upon three (3) factors.		
(1) Size of cable		
(2) Gauge of cable conductors		
(3) Length of splice opening is always three inches less than the length of the lead sleeve		
e. Ring the cable	Show students how to use the knife and ringing pliers.	
f. Apply paper paster		
(1) 1/2" overlapped on ring		
(2) Apply two layers		
g. Clean sheath 4" from paper paster back up the cable. Apply two layers of paper pasters at the end of this area.		
h. Tin the cable between the paper pasters.		
NOTE: Be careful not to burn through the sheath.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i. Remove the lead sheath. (Remove the sheath in such a manner as to leave a bell at the butt of the cable.)		
j. Rotate the cable core as necessary to aline the units or binders.		
k. Butting the cable, using one of the three methods: (1) Tucking method (2) Wrapping method (3) Cotton-sleeving method	Use C/B to show different methods if necessary.	
l. Remove moisture by boiling out the pairs with paraffin or impregnated wax. CAUTION: Stress safety at this point because of the danger of the mixture catching on fire. (1) Paraffin is heated between 375°F and 390°F (380°F ideal). 191°C. (191 degrees Celsius) (2) Impregnated wax is heated to 250°F. (120 degrees Celsius)		

m. After boiling out the cable, position the conductors so that the back pairs can be spliced first.

n. Testing and Bording of pairs

   (1) When numbered splice is required

   (2) Delete when random splice is made

o. Joining the conductors

   (1) Place the sleeves as indicated. Twist the wires of each pair together after placement is completed.

   (2) Grasp 1 pair of wires in cable A between the thumb and forefinger of the second hand. Grasp another pair of wires (cable B) between the thumb and forefinger of the first hand.

   (3) Bring both pairs together for splicing allowing enough slack to insure a symmetrical layup of completed splice.

(4) Give both pairs a 1/2-turn twist to break the insulation.

(5) Grasp both pairs in the first hand, slide the first hand along both pairs until the proper tail length is reached and cut both pairs with the splicer's scissors. Observe that the tail is required for 24-gauge wire. A slightly longer tail is required for heavier wire.

(6) Use the second and third fingers of the second hand to hold both pairs against the palm of the second hand; grasp the wires just above the twist and remove the insulation. If the insulation will not remove easily, place the wires between the thumb and the back edge of the spoicer's scissors. Then pull the insulation from the conductors.

(7) While removing the insulation from the wires with one hand, separate the wires of the other pair as illustrated in JS 1.2.1.1J.

(8) Slide the first hand under pair 1 of cable A and allow pair 1 to rest on the first hand. Grasp pair 1 of cable B with the first hand and

strip the insulation from the wires with the second hand. With the first hand, grasp the "ring" wire. Push the "tip" wire to the side with the free fingers of the first hand.

(9) Grasp the "ring" of cable B with the second hand; draw the wires together and give them a 1/2-turn twist. Include about 1/4-inch insulation of both wires in the twist. This will prevent unfurling.

(10) Grasp the wires between the thumb and forefinger of the first hand and roll one wire over the other. Grasp the tails of both wires between the thumb and forefinger of the second hand and bend the tails perpendicular to the section of wires in the first hand. Hold tightly the section of wire in the first hand. Twist the first hand section by cranking with a wrist movement of the second hand, allowing both wires to turn loosely between the thumb and forefinger of the second hand. Continue cranking until a pigtail (twisted section) of 1/2- to 1-inch length is formed.

(a) Continue cranking until the pigtail is forced behind the thumb and forefinger of the first hand. After a little practice, you can make the pigtail by forming several twists with the wires held loosely in the second hand. The finished pigtail should be loosely twisted at the neck and tightly twisted at the free end. Neck looseness reduces the possibility of breakage, and free-end tightness provides good electrical contact.

(b) Crank 19- and 16-gauge wires to form a pigtail with a definite change from looseness to tightness.

(c) Hold both wires especially tight at all times between the thumb and forefinger of the first hand when cranking 26-gauge to 22- or 24-gauge wires and when cranking 24-gauge to 19-gauge wires. If this procedure is not followed, a spiraling of the smaller around the larger wire (not a twisting together of the two wires) will result.

(11) Grasp the sleeve with the thumb and forefinger of the first hand. Bend

the pigtail to an angle of approximately 45 degrees with the scissors in the second hand. Determine the overall length of the pigtail and determine the length of the tightly twisted end of the pigtail. The overall length should vary from approximately 1 3/8 inches for 24- or 26-gauge conductors to approximately 1 3/4 inches for 16- or 19-gauge conductors. The length of the tightly twisted end should vary from approximately 3/8 inch for 24- or 26-gauge conductors to approximately 1/2 inch for 16- or 19-gauge conductors. Complete the joint by cutting the pigtail to the required length with the scissors held in the second hand.

(12) Slip the sleeve over the pigtail with the first hand and reach for the "tip" wire with the second hand. Now repeat the operations in steps 1 through 12 until all the conductors have been joined.

(13) Be sure the pigtails you make are good. Notice the length of the tight turns and the loose turns; observe the square-cut ends and the overall length and straightness of the pigtail. All of these factors are important.

(14) Arrange the joints in rows to ensure a proper splice buildup. The number of rows is directly proportional to the splice opening length.

(a) Allow approximately one-fourth inch between adjacent rows.

(b) Do not allow the sleeves of one row to overlap those of another.

(c) Arrange the number of sleeves in each row to provide a uniform size for the entire length of the completed splice.

(d) Locate the end rows the same distance from each end of the splice opening

p. After completion of the pair splicing boil out the splice again.

q. Wrapping the splice with muslin

(1) Start at the center and wrap the splice with two half-lapped layers of dry muslin tape finishing off at the center of the splice.

(2) Secure the end of the muslin with a slip knot.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
r. Give the splice a final boiling out with paraffin.		
3. Position the Sleeve Over the Splice		
a. Clean and sterine both the sheath and sleeve		
b. Position the sleeve over the splice opening		
c. Beat the sleeve ends tightly around the sheath		
4. Paper Pasters		
a. Limit the width of the joint by placing paper pasters around the cable and sleeve.		
b. Recommend that you use two layers of paper pasters on the splice		
5. Placement of the Catch Pan		
a. Secure catch pan below joint		
b. Place a dry paper (newspaper) in the bottom of the pan. This aids in returning the cold solder to the heating pot.		

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

6. Procedure for Wiping the Sleeve

   a. Place the wiping cloth in a convenient location because time is of the utmost importance when the wiping begins.

   b. Hold the catch cloth slightly below the joint.

   c. Pour one ladle of solder slowly over the sheath and sleeve, moving the ladle in a circular motion at all times.

   d. Build up the heat in the sleeve and sheath.

   e. Raise catch cloth so the side edges touch the pasters, maintaining the center of the cloth in the shape of a cup or pocket.

   f. Continue pouring the solder, distributing it over the top and sides of the joint.

   g. Insure uniform distribution of solder over the joint.

   h. When the solder gets mushy bring it up to the top of the splice.

i. Insure that the joint is well heated. DO NOT OVER HEAT.

j. Form and pack the joint

k. Make the final three wipes

7. Testing the Splice

a. Perform pressure test

b. Remove about 18" of the sheath from each end of the splice for testing purposes.

c. Test with a TS-420/U, Telephone Test Set or equivalent (76C) for tone of each conductor.

J. Bridge Splice, Lead

1. Prepare the lead sleeve

a. Cut sleeve ends squarely

b. Bevel edges of both ends

c. Clean two areas at each end of sleeve

d. Coat cleaned areas with sterine

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

    e. Beat down one end until it fits over the cable

2. Preparing the lead sheath cable
    a. Avoid severe bending
    b. Allow for proper overlaping of cable ends
    c. Establish center line
    d. Ring the cable
    e. Apply paper pasters
    f. Clean sheath
    g. Tin the cable between the paper pasters
    h. Remove the lead sheath
    i. Rotate the cable core, as needed
    j. Butting the cable
    k. Remove moisture by boiling out
    l. Position the conductors so that the back pairs can be spliced first.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
m. Testing and Bording of pairs as required		
n. Joining the conductors		
o. Boil out splice		
p. Wrapping the splice with muslin		
q. Give the splice a final boiling out with paraffin		
3. Position the sleeve over the splice		
a. Pre-clean and sterine both the sheath and the sleeve as needed		
b. Position the sleeve over the splice opening		
c. Beat the sleeve ends tightly around the sheath		
4. Paper pasters		
a. Limit the width of the joint by placing paper pasters around the cable and sleeve		
b. Recommend that you use two layers of paper pasters on the splice		

5. Placement of the catch pan
    a. Secure catch pan below joint
    b. Place a dry paper (newspaper) in the bottom of the pan
6. Procedure for wiping the sleeve
    a. Place an 18" x 1/2" piece of cotton tape in the bridge end
    b. Place the wiping cloth in a convenient location because time is of the utmost importance when the wiping begins
    c. Hold the catch cloth slightly below the joint
    d. Pour one ladle of solder slowly over the sheath and sleeve, moving the ladle in a circular motion at all times
    e. Build up the heat in the sleeve and sheath
    f. Raise the catch cloth so the side edges touch the pasters, maintaining the center of the cloth in the shape of a cup or pocket

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

g. Continue pouring the solder, distributing it over the top and sides of the joint

h. Insure uniform distribution of solder over the joint

i. When the solder gets mushy bring it up to the top of the splice

j. Insure that the joint is well heated. DO NOT OVER HEAT

k. Form and pack the joint

l. Make the final three wipes

m. Wipe out the crotch area of the bridge splice with the 1/2" cotton tape

7. Testing the splice

a. Perform pressure test

b. Remove about 18" of the sheath from the ends of the splice for testing purposes

c. Test with a TS-420/U, Telephone Test Set or equivalent (76C) for tone of each conductor.

(

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

K. Butt Splice, Lead

1. Prepare the lead sleeve
    - a. Cut sleeve ends squarely
    - b. Bevel edges of both ends
    - c. Clean two areas at each end of sleeve
    - d. Coat cleaned areas with stearine
    - e. Beat down end until it fits over the choker
2. Preparing the lead sheath cable
    - a. Avoid severe bending
    - b. Allow for proper overlaping of cable ends
    - c. Establish center line
    - d. Ring the cable
    - e. Apply paper pasters
    - f. Clean sheath
    - g. Tin the cable between the paper pasters

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
h. Remove the lead sheath		
i. Rotate the cable core		
j. Butting the cable		
k. Remove moisture by boiling out		
l. Position the conductors so that the back pairs can be spliced first		
m. Testing and Bording of pairs		
n. Joining the conductors		
o. Boil out splice		
p. Wrapping the splice with muslin		
q. Give the splice a final boiling out with paraffin		
3. Position the sleeve over the splice		
a. Re-clean and stearine both the sheath and the sleeve as needed		
b. Position the sleeve over the splice opening		
c. Beat the sleeve ends tightly around the sheath		

(

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

4. Paper pasters

   a. Limit the width of the joint by placing paper pasters around the cable and sleeve

   b. Recommend that you use two layers of paper pasters on the splice

5. Placement of the catch pan

   a. Secure catch pan below joint

   b. Place a dry paper (newspaper) in the bottom of the pan

6. Procedure for wiping the sleeve

   a. Place an 18" x 1/2" piece of cotton tape in the butt splice

   b. Place the wiping cloth in a convenient location because time is of the utmost importance when the wiping begins

   c. Hold the catch cloth slightly below the joint

   d. Pour one ladle of solder slowly over the sheath and sleeve, moving the ladle in a circular motion at all times

- e. Build up the heat in the sleeve and sheath
- f. Raise the catch cloth so the side edges touch the pasters, maintaining the center of the cloth in the shape of a cup or pocket
- g. Continue pouring the solder, distributing it over the top and sides of the joint
- h. Insure uniform distribution of solder over the joint
- i. When the solder gets mushy bring it up to the top of the splice
- j. Insure that the joint is well heated. DO NOT OVER HEAT
- k. Form and pack the joint
- l. Make the final three wipes
- m. Wipe out the crotch area of the butt splice with the 1/2" cotton tape

7. Testing the splice
   - a. Perform pressure test
   - b. Remove about 18" of the sheath from the ends of the splice for testing purposes

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Test with a TS-420/U, Telephone Test Set or equivalent (76C) for tone of each conductor		
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	Student will follow instructions in Job Sheets listed for each splice
1. Make a straight splice in accordance with Job Sheet 1.2.1.1J		
2. Make a Bridge Splice in accordance with Job Sheet 1.2.1.2J	Hand out splicing tools and materials as required for each splice	
3. Make A Butt Splice in accordance with Job Sheet 1.2.1.3J	Supervise and assist as necessary	
	Stress safety factors	
	As students complete each splice, test it	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Types of Splices to be Made		
B. Applications of Telephone Cable	Do not introduce new material	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Terms and Definitions Used In Telephone Cable Splicing	Have students hold all questions until completion of summary	
D. Basic Geometric Patterns		
E. Conductor		
F. Insulation of Conductors		
G. Basic Counting Procedure		
H. Composite Cable		
I. Straight Splice, Lead		
J. Bridge Splice, Lead		
K. Butt Splice, Lead		Ask questions after completion of summary
V. Test:	Hand out splicing tools and materials as required for each splice	Student will demonstrate knowledge by making a straight, bridge, and butt splice
A. Make a Straight Splice in accordance with Job Sheet 1.2.1.1J	Stress safety factors	
B. Make a Bridge Splice in accordance with Job Sheet 1.2.1.2J	Inform students they will be performing without instructor assistance	
C. Make a Butt Splice in accordance with Job Sheet 1.2.1.3J	Grade student on Go/No Go basis as he completes each splice	Position each completed splice on test frame

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
VI. Assignment:	Ask oral questions on reading assignment	Participate by answering oral questions
A. Read and Study TM 11-372-1:		
1. Practice - page 2-110 thru 2-121, par 2-213 thru 2-260		
2. Terms - page 1-20 thru 1-22		
3. Patterns - page 1-2 thru 1-13, par 1-14 thru 1-48		
4. Sheath Preparation - page 2-45 thru 2-50, par 2-91 thru 2-110		
5. Boiling Out - page 3-9 thru 3-12, par 3-33 thru 3-45		
6. Cotton Sleeves - page 3-12 thru 3-13, par 3-45 thru 3-49		
7. Splicing (Twist) Wires - page 3-52 thru 3-59, par 3-106 thru 3-118		
8. Lead Sleeves - page 2-103 thru 2-110, par 2-187 thru 2-112		
9. Tagging - page 2-135 thru 2-138, par 2-302 thru 2-310		

OUTLINE OF INSTRUCTION INSTRUCTOR ACTIVITY STUDENT ACTIVITY

10. Preparatory Splicing - page 3-1 thru 3-8, par 3-1 thru 3-3

11. Conductor Arrangement - page 3-71 thru 3-73, par 3-146 thru 3-153

B. Read and study T.O. 31W3-10-15:

1. Conductor Identification - page 3-6 thru 3-9, par 3-31 thru 3-41

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING [illegible] 721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.2.2 PLASTIC SHEATHED CABLE JOINTS

TIME ALLOCATION: Classroom 7 Hours
Practical 29 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
   - a. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1
   - b. Splicing Telephone Cable, Setting Up Cable, TM 11-372-2
   - c. Standard Installation Practices Outside Plant Cable Pressurization, TM 11-372-5
   - d. Telephone Cable Splicing: Cable Testing, TM 11-372-6
   - e. Outside Plant - Cable Testing, USAF T.O. 31W3-10-15, dated 1 July 1970
   - f. Construction Electrician 3 & 2, NAVPERS 10636-G
2. Reference:
   - a. Telephone Cable Splicing, Terminations and Cable Repair, TM 11-372-7
   - b. Cable Splicing Handbook 2, 1972, AT&T Compan
3. Training Aids:
   - a. Display board
     - (1) Types of Plastic Sheathed Telephone Cab
     - (2) 1A1 Ready Access Kit
     - (3) 1B1 Ready Access Kit
   - b. Color Codes, 1.2.2.1I
   - c. Straight Splice, Plastic, 1.2.2.1J
   - d. Bridge Splice, Plastic, 1.2.2.2J
   - e. Butt Splice, Plastic, 1.2.2.3J
4. Training Aids Equipment; None
5. Tools and Equipment
   - a. Cable splicer's tool box

6. Material:

   a. 1A1 Ready Access Kit

   b. 1B1 Ready Access Kit

   c. "B" connectors 19 to 26 AWG

   d. Scotchlock Connectors

      (1) UY 19 to 26 AWG

      (2) UR 19 to 26 AWG

      (3) UG 19 to 26 AWG

   e. Pick-A-Bon Splice Connector

   f. RF (Reenterable Filled)
      Closure, Scotch 3925

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.2 Upon completion of this unit the student will be able to splice telephone cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

1. Plastic sheathed telephone cable

   a. Straight splice - 4.0 hours

   b. Butt splice - 4.0 hours

   c. Bridge splice - 4.0 hours

All splices will be constructed in accordance with TM 11-372-1 through 8 and Job Sheet CE "C" 1.2J series, and will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.2.2 Upon completion of this topic the student will be able to construct a straight, butt, and bridge splice in a plastic sheathed telephone cable utilizing the proper tools and materials in accordance with TM 11-372-1, 2, 5, and 6; and Job Sheets CE "C" 1.2.2.1J, 1.2.2.2J, and 1.2.2.3J without deviation. All splices will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

CRITERION TEST

The student will construct a straight, butt, and bridge splice in a plastic sheathed telephone cable utilizing the proper tools and materials in accordance with TM 11-372-1, 2, 5, and 6; and Job Sheets CE "C" 1.2.2.1J, 1.2.2.2J, and 1.2.2.3J without deviation. All splices will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

HOMEWORK: Read and study TM 11-372-1, chapters 2 and 3

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	
D. Overview	State topic objective	
	Explain the method(s) to be used	
	Topic Criterion Exercise: How? When?	
II. Presentation:	Make ready the T/A(s) listed for this lesson	
A. Types of Plastic Sheathed Telephone Cables	Hand out text and Job Sheets for this lesson	
1. Cables are formed with various types of protective covering known as sheath or sheath protection. Basically this protection is of five types.		
a. Plastic		
b. Lead		

c. Jute

d. Tape armor

e. Wire armor

Physical make-up of the cables and disposition of their sheaths for splicing.

a. ALPETH (PE-22) (Aluminum, Polyethylene)

  (1) Plastic insulated conductors, plastic core wrapper, aluminum jacket applied longitudinally with overlap and an outer Pe sheath.

  (2) It is used aerially and for short runs in conduit or duct.

b. ALPETH (PE-23) (Polyethylene, Aluminum or Copper, Polyethylene)

  (1) Plastic insulated conductors, plastic core wrapper, Pe innersheath, a longitudinally applied copper sheath with overlap, Pe outer sheath.

  (2) It is used for direct burial installations (PAP-aluminum Sheath instead of copper).

c. STALPETH (Steel, Aluminum, Polyethylene)

(1) Uses paper insulated conductors, plastic or paper case wrappers, and aluminum sheath applied longitudinally with overlap, tinned steel with soldered longitudinal seam, a flooding compound and an outer sheath of Pe.

(2) It is used in Underground and aerial installations.

d. DS STALPETH (Double Sheathed Steel, Aluminum, Polyethylene and Flooding Compound)

(1) Paper insulated conductors, plastic or paper core wrapper, an inner sheath of Pe, an aluminum sheath applied longitudinally with overlap, tinned steel with soldered longitudinal seam, a flooding compound and an outer jacket of Pe.

(2) It is used in buried installations but may be used aerially and underground where situation warrants. (PASP is another descriptive abbreviation for this cable.)

e. Jute Protected Cable

(1) Consists of two layers of asphalt impregnated paper and one or two layers of jute.

f. Regular Tape Armor Cable

(1) Consists of two types.

(a) The main cable

(b) Equipment stub cable

(2) The type used in main cable is formed with protection consisting of one or more inner layers of asphalt-impregnated sheath wrapping paper, as outer layer of jute, one or two layers of steel or aluminum tape, an intermediate layer of asphalt impregnated sheath wrapping paper, and an outer layer of jute or thermoplastic.

(3) The type used in the equipment stub cable is formed with protection consisting of a layer of plastic, two layers of steel tape, and an outer layer of jute.

g. Wire armored cable (Single and Double wire)

(1) Single-wire armor cable consists of a bedding of jute or plastic, a layer of steel wires, and sometimes an outer layer of jute

(2) Double-wire armor cable has an additional layer of steel wire and jute

B. Color Code For Plastic Insulated Cable Pairs

1. Textile insulated color code

   a. Made up of 20 pair to each binder group

   b. Each pair may be distinguished from all other pairs in the binder group

2. Even-count (5 x 5 count).

   a. Used on plastic-insulated conductor cable

   b. 25 pairs in a binder group using 10 colors, which consists of 5 ring and 5 tip colors

      (1) 5 ring colors:

         (a) Blue

         (b) Orange

         (c) Green

(d) Brown

(e) Slate

(2) 5 tip colors:

(a) White

(b) Red

(c) Black

(d) Yellow

(e) Violet

c. No duplication of pair colors in binder group

3. How to find and identify a particular pair when only pair number is known

a. Example: Pair 921, find the binder number, binder color, the pair number in the binder.

First divide 921 by 25

```
                36    Quotient
Divisor    25 /921    Dividend
               75
               171
               150
                21    Remainder
```

b. The remainder is 21, the pair number in the binder group. The quotient shows that the binder colors have been gone through 36 times.

c. Take the quotient 36 and add one (1) to it. Then divide by the number 24.

Example:

$$\begin{array}{r} 36 \\ \underline{+1} \\ 37 \end{array}$$

Then divide by 24

$$\begin{array}{r} 1 \\ 24\,\overline{)37} \\ \underline{24} \\ 13 \end{array}$$

= The color of the binder where to find pair 921 in.

d. Binder Number is 37

e. Binder Color is 13 (Black-Green)

f. Pair Number in binder 37 is 21

4. Spiracode

a. Positive identification of pairs

b. Simple code using the 10 colors of the even-count code

c. Each conductor has two colors

(1) Tip conductor has a spiral of the ring color in it

(2) Ring conductor has a spiral of the tip color in it

C. Uses of Plastic Telephone Cable

1. Even-count cable is used in underground and aerial installations

2. Spiracode is used mainly indoors

D. Splice Closures and Locations

1. Many different types in use today

a. 1A1 and 1B1 Ready-Access kit used during this course of instruction

b. Reenterable cable closures will be used also

2. Description of types 1A1 and 1B1 Ready-Access kits

a. Cover - Molded neoprene rubber which forms a flexible closure around the body of the splice. It forms a weather-resistant cover when fitted around the nipples and base assembly.

b. Nipples - Found at each end, single or double-coned shaped, which form weather-resistant cable entrance holes at each end of the kit.

c. Base - Consists of a molded neoprene strip fastened between metal strips and has 24 numbered entry points for drop wires.

   (1) At each end of the base, double sheath clamps are provided for fastening the closure to the cable. The tie rod holds the sheath clamps in position.

   (2) Cables are fastened in these sheath clamps by means of an inner clamp or adapter assembly. The adapter assembly consists of an inner clamp, two spacers and a length of lead lashing wire. The lashing wire holds the spacers in place until the sheath clamps grip them.

(3) Each end of the closure is fastened to the suspension strand by a suspension bracket and strand lug. These serve as the electrical bond between the closure, the cable sheath, and the strand.

(4) Lengths of sealing tape are included for making drip collars.

3. The closure should be positioned to provide the best arrangement for the entering cables. Do not place the closure any nearer to the suspension bolt than 18 inches. The 1A1 and 1B1 closures are used:

   a. At the junction of underground and aerial PIC cables

   b. At an aerial branch location

E. Sheath Preparation

1. Place the cables in the final position and use temporary ties to hold in place.

2. Place paper tape collars on the sheath to mark the location of the closure. This should be 21 3/4" between the outside measurements of the collars of tape.

   NOTE: Use 1/2" tape only. The tape goes on the inside of the marks.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

3. Mark the sheath inside the collars 2 3/8"

4. Ring the sheath at these marks, scoring completely around and half-way through the polyethylene.

5. Cut the polyethylene along the length of the cable up to the scored rings.

6. Peel off the polyethylene, tearing off around the ring in the direction of the overlap of the underlying metal.

7. Nick the metal sheath at the rings and peel it off.

8. Form 1 3/4" long tabs at each end of the sheath opening, stopping short of the paper tape marker by about 1/2".

   NOTE: Do not damage the core wrapper.

9. Make an additional cut to enlarge the side opening facing the workman to 1/8" from the inner clamp.

10. Place a temporary bond across the sheath opening.

11. Carefully bend the tabs away from the core.

    NOTE: Do not bend the tabs sharply, since the aluminum may tear at the base of the tabs. Also, remove all projecting slivers of metal to prevent puncturing of the core wrapper.

12. On cables over 0.6" in diameter, form a collar around the core wrap.

13. Slide the collar under the tabs as far in as it will go.

14. On cables less than 0.6" in diameter, wrap the collar with five turns of D vinyl tape.

15. Select inner clamps (and adapter assemblies, if used) on the basis of cable diameter.

16. Slide the inner clamp over the end of the cable core.

    NOTE: If the cable is not cut spread the clamp apart before placing it over the core; then close the clamp.

17. Work the clamps back under the tabs until the measurement of 16 3/4" between them is obtained.

F. Installing The Base Assembly

1. After preparing the sheath opening, center the base assembly on the sheath opening with the clamp brackets behind the cable. Use houseline ties to support the base assembly and the through cable from the strand.

NOTE: Do not use adapter assemblies on cables of the following sizes if the cables are provided with the inner clamps listed below:

Closure	Cable Size	Inner Clamp
1A1	0 to 1.0 in.	P16E198
1B1	1.6 to 2.2 in.	P16E199

2. Clamp cable ends in the above range of sizes directly between the sheath clamp and the clamp bracket.

3. Use adapter assemblies for cables of the following sizes:

Closure	Cable Size	Inner Clamp	Adapter Assembly
L 1A1	0 to 1.0 in.	P16E198	138B
1B1	1.0 to 1.5 in.	P16E200	138A

4. Fasten the two spacers of the adapter assembly over the inner sheath clamp with lead lashing wire. Use three turns of lashing wire and terminate.

5. Fasten the adapter assembly between the sheath clamp and the bracket. Make sure that both the upper and lower sheath clamps and the tie rod are in position before tightening either clamp.

6. Insert the middle bolt in the P16E808 bracket and place the bracket over the clamp ends at the middle of the assembly. Tighten each of the three bolts a few turns at a time, starting with the middle bolts. Make sure that the adapter assembly is seated in the grooves of the sheath clamps.

   NOTE: Electrical continuity between the cable sheath and the closure depends on good contact between the folded ears of the inner sheath clamp and the adapter and sheath clamp assembly.

7. Remove the temporary bonding across the sheath opening

8. Form drip collars of sealing tape on the cable sheath at each end close to the sheath clamp bracket.

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

9. Place two turns of D vinyl tape over each drip collar to prevent the cover from adhering to the sealing tape.

10. When a 1B1 closure is used on a cable that is less than 1 inch in diameter, build up a cone-shaped collar to seal off space between the cable and the terminal nipple.

G. Core Preparation And Joining Polythylene-Insulated Conductors.

1. Even-count polyethylene-insulated conductor cables are fully color coded, with pairs arranged in 25-pair binder groups. After opening the cable, mark each binder group individually to keep the pairs permanently associated. Do this by using short lengths of paired polyethylene-insulated conductors of the same color combination as the binder, or by using colored plastic rings.

2. Tie off the ends of each binder group so the pairs will not unravel.

3. It may be necessary to rotate the core to allow alignment of binders as close as possible.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Splice the polethylene-insulated conductor (PIC) cable pairs color to color unless otherwise specified.		
5. After all the binders have been marked, carefully bend them back out of the way.		
6. Start at the lower back side by taking the binder from the left side and bring it over to the right side and tie it off. Then lay it back to the right and cut the ends off about 1/4" from the inner jacket.		
7. Splice the first 12 pair, then cut the remaining pairs off 1/4" back of the base of the first 12 pair.		
8. The next binder is taken from the left to the right side and tied with the corresponding binder group. It is then layed back to the left and cut 1/4" from the inner jacket, then spliced in the same manner as before. Stagger the binder group as before.		
9. The binders are staggered so that the splice takes on an even appearance.		
10. Various types of compression connectors used.		

a. "B", "UR", and "UY" are used on straight, butt, and bridge splices.

b. "UG" connector is for a bridge splice only.

c. Pick-A-Bon splice connector

H. Fitting the Cover.

1. The nipples used at the ends of the cover are grooved, with the diameters of the grooves marked on it.

2. Select the proper grooved nipple for each cable and cut off the outside portions of the tapered ends.

3. Fit the nipples around the cables at each end, then slide the nipples over the suspension bracket until the projection on the side of the bracket clears them.

4. Fasten the strand lug to the suspension bracket at each end then fasten the strand lug to the strand. Remove the houseline ties.

5. Starting from the rear, work the cover between the strand and the sheath clamp.

6. The sides and bottom of the cover are grooved to match the grooves in the

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
nipples and the base strip. Work all cover edges so that all grooves are firmly seated. Then clip in place with the bottom and end clips.		
7. Plug unused cable openings in the nipples with the P16E508 plug for the 1A1 closure and the P16E518 plug for the 1B1 closure.		
8. Tape all nipples to the entering cables with two half-lapped turns of D vinyl tape.		
9. In removing the cover, unfasten the bottom and end clips. It is not necessary to remove the nipples.		
I. Sheath Preparation, Bridge.		
1. The bridge cable is prepared the same as the main cable. The only change is when small cables are used it becomes necessary to use an adapter so as to maintain the continuity between all cables.		
2. Be sure that you mark the cables properly so that the inclosure will fit.		
J. Core Preparation and Joining Polyethylene Insulated Conductors, Bridge.		

1. Rotate the cable core if necessary

2. When making a bridge splice in existing main cable or during a new installation the fold back method will be used.

3. Pair preparation is the same for the bridge splice as it was for the straight splice with one exception; the type of connector that is used is different.

   a. For new construction use SCOTCHLOCK "UR" or "B" connectors.

   b. For existing cables use the SCOTCHLOCK "UG"

4. The cover is put on the splice in the same manner as before.

K. Installing the End Seal Kit

1. Cut the remaining cable pairs as they will not be used at this time.

2. Cut the individual conductors at random lengths to reduce the possibility of shorts or crosses. These random ends should not be more than 1" from cable end.

3. When the cable ends are fully prepared, secure the cup into desired position for potting. Mix the "UNIPAK" Brand Container of "SCOTCHCAST" Resin No. 17 per instructions on the guard bag.

4. Chip off corner of "UNIPAK" Container and pour resin into the cup until approximately 1/2 full.

5. Insert cable conductors down in the plastic cup and top off with remaining resin if needed.

6. Allow to remain undisturbed until the assembly can be clamped.

7. After the kit has set it is time to close the inclosure as in the straight and bridge splice.

8. Test the splice with a Telephone Test Set TS-420(B)/U or equivalent.

L. Butt Splice, Using the 1A1 Ready Access Kit

1. The cable is prepared the same as the bridge splice, except that the cable core is not cut at this time.

2. After the cables are in place, install the terminal block with 6 pair on it.

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

3. Use the "UG" connector to connect the 6 pair.

4. Put cover on splice as in bridge and straight splices.

5. Test the splice with a Telephone Test Set TS-420(b)/U or equivalent

M. Reenterable Buried Cable Closures

1. Scotch R. F. Closure

   a. Three sizes

      (1) 3924

      (2) 3925

      (3) 3926

2. Cable preparation for 3925

   a. Do not nick or cut underlying layers during the following operations.

   b. Scuff 200 mm (8") of sheath at sheath cutback point

   c. Wrap tape over scuffed area

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

Note: This tape keeps cable filler off sheath until closure ends are in place.

d. Ensure proper opening is maintained

e. Splice opening will depend on the cable size.

(1) 3 to 12 pair - 150 mm (6")

(2) 18 to 50 pair - 250 mm (10")

(3) 72 to 100 pair - 400 mm (16")

f. Mark the cable 19 mm (3/4") from the scuff toward the end of the cable and remove all the outer sheath and shielding down to the core.

g. Remove another 19 mm (3/4") of the outer sheath leaving the shielding intact.

Note: This shielding will be used in grounding cable.

h. Train cables into proper place and install scotchlock 4461 shield connector.

i. It may be necessary to take up slack in cable if the main run is not cut.

j. Remove tape from scuffed area on cable sheath.

k. Trim closure ends to fit slightly loose on cable sheath, allowing for moisture buildup

l. Cut closure bodies at cutoff point:

  (1) 3 to 12 pair - 150 mm (6") - Cutoff point A.

  (2) 18 to 50 pair - 250 mm (10") - Cutoff point B.

  (3) 75 to 100 pair - 400 mm (16") - No cutoff point.

m. Snap body top onto end tops. Hold this assembly against cable and mark 4 locations where closure ends meet cable.

n. Wrap sufficient mastic at marked locations to seal closure ends when attached. Wrap and press mastic around bridge or service wire spliced cable.

o. Position closure so ends line up over mastic rings and attach end tops to end bottoms.

Note: Tongue and groove sections must be snapped together for proper attachment.

p. Wrap scotch 88T tape over mastic on outside edge of ends.

q. Remove body top from ends and attach hose clamps.

CAUTION: Do not move ends during this operation.

r. Wrap scotch 88T tape over mastic on inside edge.

Note: Wrapping of tops in steps p. and r. assures proper seal of 4401 compound.

s. Mix Unipak 4401 Encapsulating Compound per instruction on bag. Pour into each fill port until ends are filled.

3. Splicing the conductors using only filled connectors.

   a. Splice wired with 75 mm (3") pigtails so that the splice can be tied in a round shape to cut down on splice diameter.

OUTLINE OF INSTRUCTION INSTRUCTOR ACTIVITY STUDENT ACTIVITY

Note: When the main cable must be cut it is very important that you plan your splice before working on it.

4. Closure installation

   a. Cut off the tip of a 4422 cartridge nozzle about 3 mm (1/8") from the end and puncture inner seal in nozzle.

   b. Insert 4422 cartridge into "Scotchcast" 4470 Injection Gun.

   c. Insert nozzle into wire bundle and inject more along splice bundle and uniformly fill core.

   d. Insert nozzle around shield connectors and inject 4422 packing underneath, along side, and on top connectors to eliminate voids.

   e. Use spatula to work 4422 packing into and around wire pairs and connectors to eliminate voids.

Note: Gloves are provided to keep hands clean during packing and splicing bundle wrapping.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

f. Continue injecting and working 4422 into splice until it is completely filled and covered.

g. To hold the 4422 packing in the splice in a compact bundle, wrap 45 mm (1 3/4") wide Fiberglass Tape firmly around shield connectors and entire splice. No overlap of tape is necessary.

h. Smooth out 4422 packing with spatula after wrapping fiberglass tape.

5. Closure body attachment

a. Remove hose clamps

b. Fasten body bottom onto ends

c. Fasten body top to body bottom making sure tongue and groove sides mate properly.

d. Place hose clamps around both ends of closure body and tighten. They will be in the same place as before only the body will be in place at this time.

e. Press all latches IN to assure positive locking over each hook.

6. Reenterable Encapsulant Injection

   Note: Do not inject 4422 packing until 4401 compound in ends has cured.

   a. Cut off nozzle tip of 4422 cartridge about 15 mm (1/2") from end, and puncture inner seal in nozzle.

   b. Insert cartridge into gun at a 90° angle to the splice.

   c. Continue injecting 4422 into splice until closure is filled.

   Note: Do not remove injection gun immediately. Release gun piston and wait until 4422 back pressure has forced excess encapsulant back into the cartridge.

   d. After removing gun, push cap onto injection port.

7. Reentry when necessary for repairs

   a. Remove hose clamps

   b. Pull latches out on closure body

   c. Remove closure body top and bottom

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
Note: Screwdriver pry slots are between top and bottom body to aid in removal.		
Note: 4422 reenterable encapsulant will cling to closure body halves. It may be reused if kept clean.		
d. Remove fiberglass tape		
e. Cut out splices to be changed and make new splices as before, except pigtails may be less than 75 mm (3").		
f. Pack new 4422 into and around splice bundle and over shield connectors.		
g. Wrap fiberglass tape around splice and onto shield connectors.		
h. Attach closure body halves as before and remove cap from injection port.		
i. Inject 4422 as before.		
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	Student will follow instructions in Job Sheets listed for each splice.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Make a straight splice in accordance with Job Sheet 1.2.2.1J	Hand out splicing tools and materials as required for each splice	
2. Make a Bridge splice in accordance with Job Sheet 1.2.2.2J.		
3. Make A Butt splice in accordance with Job Sheet 1.2.2.3J.	Supervise and assist as necessary. Stress safety factors. As students complete each splice, test it.	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Types of Plastic Sheathed Telephone Cables	Do not introduce new material	
B. Color Code For Plastic Insulated Cable Pairs	Have students hold all questions until completion of summary	
C. Uses of Plastic Telephone Cable		
D. Splice Closures and Locations		
E. Sheath Preparation		
F. Installing The Base Assembly		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
G. Core Preparation and Joining Polythylene-Insulated Conductors		
H. Fitting the Cover		
I. Sheath Preparation, Bridge		
J. Butt Splice, Using the 1B1 Ready Access Kit		
K. Installing the End Seal Kit		
L. Reenterable Buried Cable Closures		Ask questions after completion of summary
V. Test:	Hand out splicing tools and materials as required for each splice.	Student will demonstrate knowledge by making a straight, bridge, and butt splice
A. Make a Straight Splice in accordance with Job Sheet 1.2.2.1J.	Stress safety factors.	
B. Make a Bridge Splice in accordance with Job Sheet 1.2.2.2J.	Inform students they will be performing these splices without instructor assistance.	
C. Make a Butt Splice in accordance with Job Sheet 1.2.2.3J.	Grade student on Go/No Go basis as he completes each splice	Position each completed splice on test frame.
VI. Assignment		
A. Read and study TM 11-372-1:	Ask oral questions on reading assignment	Participate by answering oral questions

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Types of Cable - page 2-37 thru 2-45, par 2-71 thru 2-90		
2. Pick-A-Bon - page 3-13 thru 3-35, par 3-50 thru 3-85		
3. Pick-A-Bon Connectors - page 3-48 thru 3-52, Charts and Tables		
4. Compression Connectors - page 3-59 thru 3-63, par 3-119 thru 3-123		

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.2.3 JOIN PLASTIC AND LEAD SHEATHED CABLE

TIME ALLOCATION: Classroom 2 Hours
Practical 12 Hours

INSTRUCTIONAL MATERIALS

1. Text:
   a. Construction Electrician 3 & 2, NAVPERS 10636-G
   b. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1
2. Reference: None
3. Training Aids:
   a. Display Board - Steps of Lead to Plastic Splice
   b. Desiccant - CE "C" 1.2.3.1I
   c. Joining Plastic and Lead Sheathed Telephone Cable - CE "C" 1.2.3.1J
4. Training Aids Equipment: None
5. Tools and Equipment:
   a. Cable Splicer's Tool Box
6. Material:
   a. PIC Telephone Cable, 25 pair, 19 to 22 AWG
   b. Lead Sheath Telephone Cable, 25 pair, 19 to 22 AWG
   c. Sleeve, lead, 1 1/2" x 15"
   d. Sleeve, plastic, 3/32"
   e. Pick-A-Bon Splice Connector

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.2 Upon completion of this unit the student will be able to splice a straight splice in plastic sheathed telephone cable to lead sheathed telephone cable in a 7.0 hour time limit. The splice will be constructed in accordance with TM 11-372-1 through 8 and Job Sheet CE "C" 1.2J series, and will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.2.3 Upon completion of this topic the student will be able to construct a straight splice utilizing the proper tools and materials in accordance with TM 11-372-1, Construction Electrician 3 & 2, NAVPERS 10636-G, and Job Sheet CE "C" 1.2.3.1J without deviation. The splice will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

CRITERION TEST

The student will construct a straight splice utilizing the proper tools and materials in accordance with TM 11-372-1, Construction Electrician 3 & 2, NAVPERS 10636-G, and Job Sheet CE "C" 1.2.3.1J without deviation. The splice will be required to pass an audible test signal when tested with a telephone test set TS-420(B)/U or equivalent test set to satisfactorily complete this objective.

HOMEWORK

Read and study:

1. TM 11-372-1, chapter 2

2. CE 3 &2, NAVPERS 10636-G, chapter 12

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise: How? When?	
II. Presentation:	Make ready the T/A(s) listed for this lesson	
A. Preliminary Procedures For Splicing Plastic Sheath To Lead Sheath Telephone Cable	Hand out text and Job Sheet for this lesson	
1. Determine the length and size of lead sleeve using the following table:		
a. Size of cable: 11 to 51 pair 76 to 101 pair 152 pair		

b. Length of sheath opening in inches:

11 1/2"
13 1/2"
13 1/2"

c. Size lead sleeve in inches:

1 1/2 x 15

1 3/4 x 17

2 x 17

NOTE: After the size of the cable has been determined you can determine the sheath opening.

2. Measure and mark splice location

3. Make an additional mark of 4" on the lead cable

4. Make an additional mark of 7" on the plastic cable

B. Sleeve Preparation

1. Clean the outside of the sleeve for a distance of 7" from the end that will be going on the plastic end.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Clean the other end for a distance of 2". This end will be towards the lead sheath cable.		
3. Place prepared sleeve on the lead cable		
C. Plastic Sheathed Cable Preparation		
1. Remove the outer Pe sheath at the appropriate mark		
2. Remove the shielding. (Be careful not to cut your fingers or conductors.)		
3. When applicable remove inner Pe Sheath		
4. Remove core wrapper		
5. Remove another 1/2" of outer Pe jacket		
6. Solder #24 Scotch electrical shielding tape to the Pe shield. Use 48" of this tape.		
7. Scuff seven inches of plastic sheath		
8. Prepare a cone-shaped casting form		
9. Insure the largest diameter of the form is not larger than the inside diameter of lead sleeve being used.		

10. Fashion hole in cone shaped form and slide it over cable to temporary position about 4" from Pe jacket end

11. Turn up end of cable and secure in a vertical position for casting operation

12. Move form up to casting position, and place tape if necessary to hold it in position or to close any openings. The rim of the mold will be about 1/2" above the Pe jacket of the inner Pe jacket or shielding.

13. Prepare casting mixture as per instructions associated with container.

14. When mixture is ready to be poured according to the instructions, pour it into the form until it reaches a level very close to the top.

    NOTE: Some casting resins will develop heat immediately after being mixed, so read the instructions very carefully.

15. During the pouring process the shielding tape and conductors should be moved back and forth slightly to aid the penetration of liquid.

16. Allow the mixture to harden or until it is firm and cool to the touch.

17. Peel off the form and clean the casting.

18. Bend the cable with the casting back into position for splicing.

D. Lead Sheath Preparation

1. Ring the lead sheath. Be careful not to penetrate completely through the sheath.

2. Scrapeand clean sheath thoroughly with shave hook back to the mark that you made in step A.3.

3. Immediately after cleaning the sheath, coat it thoroughly with stearine.

4. Apply two layers of paper pasters at each end of the cleaned cable.

5. Tin the 4" of cleaned lead sheath.

6. After the sheath has cooled remove that portion of the sheath in front of the tinned area.

7. Put on the choker.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
8. Spread the wires for boiling out the cable.		
9. Prepare the paraffin.		
10. Set catch pan for easy access to heating pot.		
11. Starting about 6 to 8 inches from the butt of the cable pour hot paraffin over the sheath and work it toward the exposed conductors until all conductors are thoroughly soaked.		
12. Return excess liquid to the pot.		
E. Splice Preparation.		
1. Separate conductors into bunches by color groups or complements.		
a. Secure the conductors in a convenient position.		
b. Leave suitable length for staggered splicing.		
2. As pairs are selected for splicing, place a plastic sleeve over one conductor in the opposite direction of which you will lay the conductor after the splice is made.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

3. Remove the required length of insulation from the conductors.

4. Twist the individually skinned conductors together.

    a. Make the joint 1-3/8" to 1-3/4".

    b. Stagger joints for a uniform lay.

    c. Start joint with three loose half-turns (about 1").

    d. Finish joint with five tight half-turns (about 3/8" to 1/2").

5. Cut off excess wire.

6. Bend pigtail into place and slide previously placed sleeve over the joint.

7. Wrap the body of the splice with a plastic envelope cut from a sheet of polyethylene or equivalent material. Leave a slot at the top of the envelope to put in the desiccant.

8. Put in proper amount of desiccant.

DESICCANT TABLE

Size of Cables	Weight of Desiccant in Grams
51 pair and smaller	20
76 and 101 pairs	40
152 and 202 pairs	70
Larger than 202 pairs	30 per each 100 pairs

F. Wrapping the Splice

1. Cover splice with a single layer of half-lapped vinyl tape. Do not overlap cable sheath or metallic shield.

2. Wrap the splice with Scotch #24 Copper Tape.

    a. Extend the wrap onto the lead sheathed cable.

    b. Solder the end of the shielding tape to the lead sheathed cable at the point of overlap.

G. Lead Sleeve Placement

1. Place a strip of tape (sticky side out) on the plastic sheathed cable lengthwise about 1/4" from the base of the casted end seal.

   a. Start at the base of the cast and wrap down for 2" with #24 copper tape.

   b. Wrap the copper tape tightly around the cable.

   c. Secure the strip of tape with the edge of the plastic tape.

2. Secure the edges of the wire tape with the vinyl tape tabs.

3. Press a hot iron firmly against the wire tape at numerous points around the sheath until dark patches appear through the mesh.

4. Place the lead sleeve over the splice

   a. Overlap the lead sheathed cable about 1-1/2".

   b. Overlap the wire tape on the plastic sheathed cable about 1".

5. Beat in the end of the lead sleeve on the lead sheathed cable side and wipe splice in the usual manner.

6. On the plastic sheathed cable shape the end of the sleeve to the copper wire in a gradually tapering slope.

7. Solder the sleeve to the copper tape.

H. Taping the Joint

1. Fill in the voids between the plastic sheathed cable and the lead sleeve with rubber tape.

2. Apply 2 half-lapped layers of rubber tape. Extend 2-1/2" on each side where the lead sleeve joins the wire tape.

3. Apply a collar of three turns of 4" adhesive-backed aluminum tape. Smooth into place with a cable dresser.

4. Apply 1-1/2 turns of 2" adhesive-backed aluminum tape at each end of the first collar. Overlap previously placed aluminum tape about 1/2".

5. Smooth collar with a cable dresser.

6. Apply 2 half-lapped layers of vinyl tape.

   a. Start the first layer on the lead sleeve 1" beyond the aluminum tape.

   b. Start the second layer on the lead sleeve 1" beyond the end of the

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
previous layer and extend it 1" beyond the end of the first layer.		
III. Application:		
A. Questions - (Oral questions prepared by the instructor).	Conduct oral quiz	Participate in quiz by answering questions.
B. Practical Application Period	Inform students this segment will be taught in the shop area.	Student will follow instructions in Job Sheet listed for this splice.
	Hand out splicing tools and materials as required for the splice.	
	Supervise and assist as necessary.	
	Stress safety factors	
	As students complete each splice, test it.	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Preliminary Procedures For Splicing Plastic Sheath To Lead Sheath Telephone Cable.	Do not introduce new material	
B. Sleeve Preparation	Have students hold all questions until completion of summary	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Plastic Sheathed Cable Preparation		
D. Lead Sheath Preparation		
E. Splice Preparation		
F. Wrapping the Splice		
G. Lead Sleeve Placement		
H. Taping the Joint		Ask questions after completion of summary
V. Test:	Hand out splicing tools and materials as required for each splice.	
A. Make a straight splice in accordance with Job Sheet 1.2.3.1J.	Stress safety factors	
	Inform students they will be performing without instructor assistance	
	Grade student on Go/No Go basis as he completes the splice.	Position each completed splice on test frame.
VI. Assignment:	Ask oral questions on reading assignment.	Participate by answering oral questions.
A. Read and Study:		
1. TM 11-372-1 - page 2-62 thru 2-69, par 2-141 thru 2-151		
2. CE 3 & 2, NAVPERS 10636-G, Chapter 12		

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING [illegible]-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.1 STRAIGHT SPLICE, 5 kv, RR, AWG #8

TIME ALLOCATION: Classroom 2 Hours
Practical 5 Hours

INSTRUCTIONAL MATERIALS

1. Text
    a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
    b. Terminations and Splices - Theory-Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio
2. References: None
3. Training Aids
    a. Slides - All-tape and "scotchcast" Type Material (number 3-6 thru 3-20), 35 mm 3M Products
    b. Display Board - Scotchcast 82 A-2 Kit
    c. Types of Power Cable - CE "C" 1.3.1.1I
    d. 5 kv (5000 volts) "Scotchcast" 82-Series Splicing Kit Instructions - CE "C" 1.3.1.1J
4. Training Aids Equipment
    a. Projector, 35 mm
5. Tools and Equipment
    a. Cable splicer's tool box
    b. Compression tool, TBM-2
    c. Hacksaw
    d. Sharpening stone
6. Materials
    a. Cable, 5 kv, (R-R), AWG #8, 1/C
    b. "Scotchcast" splicing kit, 82 A-2 or equal
    c. Connector, T&B No. 54504, #8 AWG (Red)
    d. Connector, Split-tinned, #8 AWG

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

TERMINAL OBJECTIVE (CONT'D)

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Rubber insulation-rubber sheathed cable, single conductor - straight splice - 2.0 hours.

   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours.

   c. Rubber insulation-lead sheathed cable - branch splice - single conductor - 14.0 hours.

   d. Varnished cambric insulation-lead sheathed cable, single conductor-termination splice - 4.0 hours.

   e. XLP shielded cable, single conductor - straight splice - 3.0 hours.

   f. XLP unshielded cable, single conductor-straight splice - 4.0 hours.

   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours.

   h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours.

   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours.

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio and job sheet CE "C" 1.3J Series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.1 Upon completion of this topic the student will be able to construct a straight splice in a 5 kv rubber insulated-rubber sheathed (R-R). AWG #8 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory-Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio and Job Sheet CE "C" 1.3.1.1J without deviation. The splice will be required to withstand an acceptance test of 33.6 kv for 15

ENABLING OBJECTIVE (CONT'D)

minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a straight splice in a 5 kv rubber insulated-rubber sheathed (R-R), AWG #8 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio and Job Sheet CE "C" 1.3.1.1J without deviation. The splice will be required to withstand an acceptance test of 33.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) Standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

Read and study Information Sheet CE "C" 1.3.1.1I.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Motivate student	
C. Establish Effect	Relate the value of the subject matter to the student	Students bring out individual needs for this lesson
D. Overview	State topic objectives Explain the method(s) to be used Topic Criterion Exercise How? When?	
II. Presentation:		
A. Cable, 5 kv	Have projector and slides ready for viewing and hand out texts, CE "C" 1.3.1.1I and CE "C" 1.3.1.1J	
1. Type		
a. R-R (unshielded)		
b. 1/conductor, S.D. Copper		
c. Insulation, butyl rubber	These areas must be emphasized.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Radial, 45 V/mil		
(2) Longitudinal, 12 V/mil at connector; 6 V/mill other	Insulation characteristics Voltage stress	
d. Sheath		
(1) Rubber	Not always rubber	
(2) Neoprene		
(3) PVC		
2. Application		
a. Power and control circuits		
b. Where		
(1) Direct burial	Polyvinylchloride and neoprene may be buried	
(2) Aerial		
(3) Conduit		
B. Splicing Kit	Hand out to each student the manufacturer's instructions from the splice kit	Student learns the applications and limitations of the resin type kits
1. Design		
a. Voltage		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) 1/C, 5 kv		
(2) Multiple conductor, 600 volts		
b. Location		
(1) Exposed		
(2) Direct burial		
2. Contents		
a. Manufacturers instruction	State what the dimensions are to be along with class participation in measurements of the connector	Measure connector to determine how much of the conductor should be exposed
(1) Splice dimensions		
(2) Procedures		
b. Materials		
(1) Plastic mold halves	View 3M slide series	
(2) High voltage tape		
(3) Pouring spouts		
(4) Resin, unipak		
C. Splicing the Cable	Make this presentation and demonstration with all of the materials and cable preparations prefabricated for expediency	
1. Prepare cable		
a. Arrange the cables into the desired final position		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Avoid severe bending		
(2) Allow slight overlap of ends		
b. Cut cables to butt squarely together at desired centerline of splice		
c. Thoroughly clean nine (9) to ten (10) inches back from each cable end	Clean with trichlorethylene on a lint free cloth	
d. Prepare cable ends as shown in the drawing		
e. Remove insulation as required to fit one half of the connector length plus one half inch on each cable end		
f. Pencil the insulation one half inch or approximately the dimension of the cable diameter	Show the student how to pencil the insulation and clean the insulation with abrasive cloth	
g. Remove all conductive threads or tape from around conductor		
2. Make connection	Demonstrate the use of the TBM-2 compression tool	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Make connection according to instruction for the connector being used		
b. Connector is not supplied with splice kit		
c. Choose a good quality connector with a smooth compact shape as follows		
(1) Indent sleeve (2) Solder sleeve (3) Compression	Explain that solder sleeves may be used on this splice if crimp type not available. Solder sleeves will be used with some of the other splices to be made.	
d. Multi-conductor cables, stagger the individual connections and insulate with scotch brand tape #23		
3. Tape over the connector area	Stretch the tape to ½" of the original width. Always maintain this stretch the full circumference of the cable	
a. Use the high voltage self bonding tape supplied with the kit		
b. Apply one layer half-lapped over the connector (only ¼" onto the pencil area)		
4. Install mold body		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Trim mold ends with knife to fit cable slightly loose		
b. Center mold halves over splice and snap together firmly		
c. Insert pouring spouts in holes		
d. Check to see that both seams are carefully snapped together		
5. Tape end of mold-body to seal ends around cable, use the tape supplied with kit or a similar rubber tape		
6. Pour splice		
a. Position splice level	Show the position of the mold	
b. Mix resin thoroughly per instructions on the exterior "guard bag"		
c. Pour resin immediately after mixing		
d. Fill mold through one spout only until both spouts are completely filled (to allow for cooling shrinkage)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. When resin has solidified and cooled the splice may be moved and put into service (approximately 30 to 45 minutes)		
f. Clip off the spouts if desired and tape over the openings	Show the completed splice	
III. Application		
A. Questions (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	
1. Make a straight splice in accordance with Job Sheet CE "C" 1.3.1.1J	Hand out splicing kit, tools and materials	Student will follow instructi in Job Sheet CE "C" 1.3.1.1J
	Supervise and assist as necessary	
	Stress safety factors	
	Test the student's splice	
IV. Summary	Review of important subject matter	Give undivided attention
A. Cable		
1. Type	Don't introduce new material	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Application	Hold all questions until completion of summary	
B. Splicing Kit		
1. Design		
2. Contents		
C. Splicing the Cable		
1. Prepare cable		
2. Make connection		
3. Tape over the connector area		
4. Install mold body		
5. Tape end of mold-body		Ask questions after completion of summary
6. Pour splice		
V. Criterion Test	Hand out splicing kit, tools and materials	
A. Make a straight splice in accordance with Job Sheet CE "C" 1.3.1.1J	Stress safety Inform students they will be performing without supervision	Student will demonstrate knowledge by performing splice

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	Grade student on go-no go basis	Position completed splice on test frame
	Have student dismantle his splice and salvage materials after test	
VI. Assignment		
A. Read and study information CE "S" 1.3.1.1I	Ask oral questions on reading assignment	Participate by answering oral questions

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.2 STRAIGHT AND BRANCH SPLICES, 5 kv, R-L, AWG #4/0

TIME ALLOCATION: Classroom 3 Hours
Practical 36 Hours

INSTRUCTIONAL MATERIALS:

1. Text
    - a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. Reference: None
3. Training Aids:
    - a. Classroom Poster - Rubber-Lead Splice
    - b. Display Board - Rubber-Lead Splice "Cut-away"
    - c. 5 kv Rubber Insulated-lead Covered Joint Construction - CE "C" 1.3.2.1J
4. Training Aids Equipment: None
5. Tools and Equipment:
    - a. Cable splicers tool box
    - b. Hacksaw
    - c. Sharpening stone
    - d. Soldering copper
    - e. Melting pot, solder
        - (1) Electric
        - (2) Cast iron
    - f. Gas furnace, butane
    - g. Windshield, furnace
    - h. Compound kettle
    - i. Cable splicer, hand
    - j. Pressure gauge, air pump
6. Materials:
    - a. Cable, 5 kv, (R-L), AWG #4/0, 1/C
    - b. Connector, split-tinned, 4/0, straight

c. Insulating tapes

   (1) Rubber, high-voltage, insulating

   (2) Friction

   (3) Cotton

   (4) Muslin

d. Insulating compound, Ozite "B"

e. Lead sleeve

f. Abrasive cloth (non-conducting)

g. Solder, 40/60 wiping

h. Solder, 50/50 seam

i. Sterine candles

j. Paper pasters

k. Copper wire, tinned AWG #14

l. Wiping rags

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be mad in each cable and the time limit prescribes are as indicated by each cable.

   a. Rubber insulation-rubber sheated cable, single conductor-straight splice - 2.0 hours.

   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours.

   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours.

   e. XLP shielded cable, single conductor straight splice - 3.0 hours.

   f. XLP unshielded cable, single conductor - straight splice-4.0 hour

   g. XLP shielded or unshielded cable, three conductor - straight splice 11.0 hours.

   h. XLP shielded or unshielded cable, single conductor - termination splic 2.0 hours.

i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours.

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.2 Upon completion of this topic the student will be able to construct a straight and a branch splice in a 5 kv rubber insulated-lead sheathed (R-L), AWG #4/0 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.2.1J without deviation. The splice will be required to withstand an acceptance test of 33.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a straight and a branch splice in a 5 kv rubber insulated-lead sheathed (R-L), AWG #4/0 power cable utilizing the appropria tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electr Institute and Job Sheet CE "C" 1.3.2.1J without deviation. The splice will be required to withstan an acceptance test of 33.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Chapter 9, pages 11 - 22.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective	
	Explain the method(s) to be used	
	Topic Criterion Exercise How ? When ?	
II. Presentation	Make ready the T/A's listed for this lesson.	
A. Cable, 5 kv	Handout text and Job Sheet JS-1.3.2.1	
1. Type		
a. R-L (shield not required)		
b. 1/conductor, stranded copper		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Insulation, butyl rubber	These areas must be stressed:	
(1) Radial Stress, 45 v/mill	Insulation characteristics	
(2) Longitudinal, 12 v/mil	Voltage stress	
(3) Semi-conducting tape	NOTE: Table III, USR 9-6	
d. Sheath - lead: provides greatest resistance to:	Lead sheath failures, USR 11-9	
(1) Moisture		
(2) Chemicals		
(3) Oil		
2. Application	Refer student to USR book, page page 1-9, Section "C", Selection of Type of Cable System and Cable	Student refers to and makes note for study
a. Power circuits		
(1) Tide water		
(2) Soaking pits		
(3) Steel mills		
b. When		
(1) Aerial (messenger supported)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Open wire indoors		
(3) Conduit/ducts		
E. Splicing the Cable		
1. Training the cable ends a. Arranging cables b. Bending radius	Refer to USR book, page 8-22, Section "D", Duct Cable: Arrangement, support. Bending radii shall be not less than 12 times the over-all diameter of the completed cable	Student refers to and makes note for study
2. Cutting cable ends a. Determine and mark cable at center line	Make this presentation and demonstration with prepared cable and materials.	
b. Cut off squarely with a hacksaw	NOTE: Refer to splice drawing for sleeve size and length in Job Sheet	Determine the size and length of sleeve to be used
c. Ends should now but squarely		
d. Do not retrain cables after cutting		
3. Placing lead sleeve a. Clean inside of sleeve	State that this is done in the same manner that was learned while splicing telephone cable	
b. Scrape each end of the sleeve thoroughly with a rasp for three to four inches		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Coat scraped portion with sterine flux		
NOTE: Lead sleeve may be beat down on the end being slid over cable to near its final formed size	Show the class the sleeve that you beat down on one end	
d. Slide the lead sleeve over one of the cable ends far enough to be out of the way while splice is being made	Slide the sleeve over the cable end	
4. Removing the lead sheath from cable	Following the dimensions from the drawing in the JS and in conjunction with the length of the sleeve, mark, score, and clean the cable sheath. This is distance "A" on print	class participates in making mresurements
a. Mark sheath 1½" less than ½ total length of lead sleeve		
b. Score or ring sheath (cut about halfway through sheath all around cable		
c. Clean cable sheath		
d. Apply sterine		
e. Apply paper pasters to sheath	Apply pasters and tin the prepared area	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Tin prepared sheath area		
g. Slit cable sheath up to the cable ring using a chipping knife held at a slant	CAUTION: DO NOT nick the conductor	
h. Remove sheath using sheath openers and tinner's hammer. Tear off at score with twisting motion, thereby forming a slight bell in end of lead sheath		
5. Belling out the lead sheath		
a. Bell out sheath approximately ¼" with a wooden separator	Show the use of the separator	
b. This will provide space for the binder tape to be carried into the bell for at least ½"		
6. Removing belt insulation (if used)	Place knife against cable and tear the belt insulation from cable	
a. Place temporary wrapping of cotton tape 1" from end of cable sheath		
b. Cut off outer layers of belt insulation	CAUTION: DO NOT cut the conductor insulation	

UTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Tear off inner layers to avoid damaging insulation		
7. Removing conductor insulation		
a. Make cotton tape ties back of trimming marks		
b. Remove factory insulation from conductor for a length equal to ½ the connector length plus ½"	Hold the connector against the conductor and mark the insulation ½" further back	
C. Connector Installation		
1. Protect area of insulation with cotton tape and other exposed insulation with muslin wrapping while installing connector		
2. Clean bare conductor throughly and apply sterine flux to exposed surface by brushing on or melt against hot ladle and drip on	Show how to clean conductor with abrasive cloth	
3. Open slot in connector sufficient to slip over conductor		
a. Slip connector over one (1) conductor	NOTE: When making the branch splice use a branch connector or wrap the branch to the main conductor with AWG 14 tinned copper wire	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Insert end of other conductor into connector until it butts first conductor squarely		
c. Center connector over conductor with slot up		
d. Tightly compress connector around conductor with pliers		
4. Soldering connector		
a. Use two solder ladles, one for hot solder and one to catch overflow		
b. Pour solder over ends of connector and into slot until connector and strands are hot enough to make solder flow freely	Apply heat and solder, making sure that connector and all dents caused by squeezing get filled with solder	
c. Apply flux and allow to run into slot and through strands		
d. Alternate pouring solder and applying flux until connector and conductor is tinned to a bright, shiny cast		
e. Allow solder to cool in ladle, and pour until solder becomes plastic and fills slot		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Smooth off burrs with dry cotton tape while connector is still hot		
g. While cooling, polish connector with a loop of 1" cotton tape		
h. Polish connector and conductor with a non-conducting abrasive cloth	Polish the connector	
D. Replacing Insulation		
1. Remove protective cloth wrapping (cotton tape)		
2. Trimming conductor insulation	When penciling is specified in the joint design, cut the insulation to a smooth regular taper with a sharp knife	
a. Pencil rubber insulation		
b. Dimensions		
3. Apply rubber tape half-lapped		
a. Fill in space at both ends between connector and trimmed insulation (start at connector ends)	Take a caliper reading over the connector	
b. Insulate over connector and pencil area to the diameter of the factory applied insulation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Continue the taping over the entire exposed area with uniform tension so the width of the tape is stretched to approximately 1/3 of its original size	After taking the dimension of the connector explain the method of determining the overall thickness of the completed tape joint. Specifications for thickness of tape insulation usually provide for two times greater thickness than the factory insulation.	
NOTE: Use extra care in crotch areas on branch joints; extend insulation back into crotch as far as possible to eliminate air voids.		
d. Rubber tape should be protected with friction tape and asphaltum paint or with a layer of weather-resistant tape if specified	Display a splice with the taping completed	
e. All tape must be applied smoothly and carefully to expel all air and avoid wrinkles		
E. Closing Splice Opening	NOTE: Installation of a sleeve is the same as previously done with telephone joints.	
1. Installing lead sleeve		
a. The lead sleeve previously slipped over the cable should now be centered over splice		

b. Beat down ends with a cable dresser until sleeve fits snugly around cable sheath

NOTE: Split sleeve would be applied at this time if required

c. Apply pasters around the sleeve at each end with one edge at the shoulder

NOTE: While learning to wipe, it is best to apply two rows of paper pasters at each end of the sleeve and also two rows on the sheath of the cable

d. Apply paper pasters around sheath at:

(1) 1/2" from sleeve on 1" diameter and smaller cable

(2) 3/4" from sleeve on 1" to 3" diameter cable

(3) 1" from end of sleeve for cables over 3" diameter

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
e. Before making wipes, provide two (2) holes in sleeve, one near each end. This will vent off expanding air while wiping the joint and provide for a means of filling the joint with compound	Make the holes with the cable chipping knife; one large enough to accommodate the spout of a funnel	
NOTE: Make holes in sleeve by cutting a "V" shape with chipping knife and curling back the "V" to the outside		
f. Making wipes (1) Use only wiping solder with the percentage of tin greater than 37% to avoid porous wipes	These wipes are a repetition of a straight and wye "Y" telephone joint	
(2) Solder should be between 550 and 650 degrees F. (At 650 degrees the surface is dark purple)		
(3) Tin the surface of the sheath and sleeve between the pasters		
(4) Continue applying solder, building up enough to make a good wipe		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(5) Use wiping cloths and catch cloths to work and compress the solder sufficiently to prevent tin from floating out		
(6) Allow wipes to cool to a temperature where the bare hand can be held on them before moving the cable		
2. Filling the joint	Each student can fill his branch joint before testing	
a. Insert filling funnel in one of the holes previously made in the sleeve. The funnel can be sealed in place with friction tape		
b. Tilt joint slightly so that vent hole is slightly higher than the other hole. The top of the filling funnel must also be higher than vent hole		
c. Pour the insulating compound, preheated to its pouring temperature, slowly and steadily into the filling funnel. Allow the compound to flow through the vent hole until all air is driven from the joint and the compound is free from bubbles		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Allow the joint to cool to 150 degrees F., level the joint and allow the compound to settle		
e. After settling, refill to eliminate all voids due to shrinkage and remove funnel		
f. After the joint has cooled down to 100 degrees F., close the filling and vent hole and seal with solder		
g. Paint wipes and seal with victolac to prevent corrosion		
III. Application:		
A. Questions -(Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	
1. Make a straight splice in accordance with Job Sheet JS-1.3.2.1	Hand out splicing tools and materials	Student will follow instructions in Job Sheet JS-1.3.2.1
2. Make a branch splice in accordance with Job Sheet JS-1.3.2.1	Supervise and assist as necessary	
	Stress safety factors	
	Test the student's splices	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
IV. Summary:	Review of important subject matter	Give undivided attention
A. Cable		
1. Type	Do not introduce new material	
2. Application		
B. Splicing the Cable	Have student to hold all questions until completion of summary	
1. Training the cable ends		
2. Cutting the cable ends		
3. Placing the lead sheath		
4. Removing the lead sheath from cable		
5. Belling out the lead sheath		
6. Removing belt insulation		
7. Removing conductor insulation		
C. Connector Installation		
1. Protect the insulation from solder with cotton tape		
2. Ensure that conductor is clean		
3. Open slot in connector		
4. [illegible]ldering Connector		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Replacing Insulation		
1. Remove protective cloth wrapping		
2. Trimming conductor insulation		
3. Apply rubber tape half-lapped		
E. Closing splice Opening		Ask questions after completion of summary
1. Installing lead sleeve		
2. Filling the joint		
V. Criterion Test:	Hand out splicing tools and materials	Student will demonstrate knowledge by performing a straight and a branch splice
A. Make a straight splice in accordance with Job Sheet JS-1.3.2.1	Stress safety factors	
B. Make a branch splice in accordance with Job Sheet JS-1.3.2-1	Inform students they will be performing without supervision	
	Grade student on go-no go basis	Position completed splice on test frame
	Have student dismantle his splices and salvage materials after test	
VI. Assignment:		
A. Read and study Underground Systems Reference Book, 1957 Ed., Chapter 9, pages 11 - 22	Ask oral questions on reading assignment	Participate by answering oral questions

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.3 TERMINATION SPLICE, 5 kv, VARNISHED CAMBRIC INSULATED-LEAD SHEATHED AWG #4/0 POWER CABLE

TIME ALLOCATION: Classroom 1 Hour
Practical 6 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
    a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. Reference: None
3. Training Aids:
    a. Display Board - Single Conductor, Type T Capnut Pothead
    b. Drawing - G & W Soldertite Pothead, Drawing # EO-4102-B, Consolidated Edison Company of N.Y., Inc.
    c. 5 kv Single Conductor Capnut Pothead, CE "C" 1.3.3.1J
    d. Installation Instruction #GWI 1-56, Single Conductor, Type T Capnut Potheads, G&W Electric Specialty Company, 3500 West 127th Street, Blue Island, Illinois
4. Training Aids Equipment: None
5. Tools and Equipment:
    a. Cable Splicers Tool Box
    b. Hacksaw
    c. Sharpening stone
    d. Pliers, eagle beak
    e. Melting pot (solder)
        (1) Electric
        (2) Cast iron
    f. Gas furnace (butane)
    g. Windshield
    h. Cable slicer (hand)
    i. Oil pan
    j. Oil pot

k. Stand, pipe

l. Funnel

6. Materials:

a. Cable, 5 kv, VCL, AWG #40, 1/C, 3' per student

b. Tapes

(1) Varnished cambric, 3/4"

(2) Shielding, copper mesh

(3) Cotton

c. Insulating oil

d. Abrasive cloth (non-conducting)

e. Solder, 40/60

f. Sterine candles

g. Paper paster

h. Wiping rags

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

a. Rubber insulation-rubber sheathed cable, single conductor - straight splice - 2.0 hours.

b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours.

c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours.

e. XLP unshielded cable, single conductor - straight splice - 3.0 hours.

f. XLP unshielded cable, single conductor - straight splice - 4.0 hours.

g. XLP shielded or unshielded cable, three conductor straight splice - 11.0 Hours.

h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours.

i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours.

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.3 Upon completion of this topic the student will be able to construct a termination splice in a 5 kv, single conductor, varnished cambric insulated-lead sheathed (VAL), AWG #4/0 Power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.31J without deviation. The splice will be required to withstand an acceptance test of 37.2 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a termination splice in a 5 kv, single conductor, varnished cambric insulated-lead sheathed (VCL), AWG #4/0 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.3.1J without deviation. The splice will be required to withstand an acceptance test of 37.2 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Chapter 9

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective	
	Explain the method(s) to be used	
	Topic Criterion Exercise a. How? b. When?	
II. Presentation:	Make ready the T/A listed for this lesson.	
A. Terminating Varnished Cambric Insulated-Lead Sheathed Power Cable	Handout text, job sheet JS-1.3.3.1, Installation Instruction #GWI 1-56, and Drawing #EO-4102-B	
1. For outdoor, shielded		
a. Lead or unleaded sheath		
b. Contaminated atmospheres		
c. Oil-stops (to prevent migration)		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Stress cones		
a. All shielded		
b. Lead or unleaded sheath		
c. Stress relief cone designs	Refer student to USR book, Ch. 9, section D, page 9-30, Table VIII	Student notes Table VIII in the text
B. Terminating Procedures		
1. Cut wiping sleeve on gauge lines to pass cable (if required) and remove any burrs or sharp edges		
2. Mount pothead on the supporting structure		
a. Form cable to the approximate final position		
b. Mark sheath even with the lower end of the porcelain insulator and the lower end of the wiping sleeve		
3. Remove wiping sleeve from lower end of the pothead and slide down over the cable		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Measure the distance from the bottom of the cable socket to the lower end of the porcelain insulator		
a. Cut the cable this measured distance above top mark on sheath		
b. Remove sheath and cable insulation at end of cable for a distance equal to the depth of the cable socket plus ½". Be careful not to open up the conductor strands		
c. Remove cable socket stud from porcelain insulator	Assist students as required	
d. Tin the end of the conductor and socket of connector and sweat together		
5. Remove lead sheath from cable down to 1" above the lower mark on sheath		
a. Bell end of lead sheath slightly by properly scoring and tearing		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Be careful not to injure the factory insulation		
c. Wrap .005" X ½" copper shim around cable insulation and slide it 3/16" under lead sheath		
d. Pencil insulation at cable socket for ½"		
6. Tape end of cable with varnished cambric to prevent insulation from loosening		
7. Build up insulation for stress cone of halflapped 3/4" or 1" oil-packed varnished cambric tape to dimensions shown on Table VIII, page 9-30 of text	Measure the tape buildup of the stress cones	
8. Over the cone of varnished cambric tape apply 3/4" wide copper mesh tape with one-half lap extending from the largest diameter of the cone to the cable sheath		
a. Spot solder the copper-mesh tape at points along the cone and to the cable sheath	Use minimum amounts of solder	

9. Paint entire surface of the wiping sleeve gasket with a good grade of gasket compound
    a. Allow it to become tacky
    b. Place over cable and into machined groove of wiping sleeve
10. Clean and dry the inside of the porcelain insulator
    a. Place over the cable socket and cable
    b. Be sure that the locking fins on the cable socket connector are properly located to engage in slots in porcelain
    c. If they do not engage, clamps can be loosened and the insulator rotated until they do engage
11. Bolt porcelain insulator tightly to the wiping sleeve with the filling plug in a convenient location
    a. Tighten all bolts evenly

OUTLINE OF INSTRUCTION INSTRUCTOR ACTIVITY STUDENT ACTIVITY

12. Wire brush threads on stud to remove any particles of dirt and assemble top seal as follows:

    a. Paint the entire surface of the top sealing gasket with a good grade gasket compound

    b. Allow gasket to become tacky

    c. Place in machined groove of capnut

    d. Screw capnut down on stud until there is no space between the bottom of the capnut and the top of the porcelain bushing

13. Screw venting and stud positioning plug and gasket into the hole in side of capnut. If plug does not screw all the way in, the cable has been cut too long and the pothead must be taken apart and corrections made

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
14. Use sterine as a flux and wipe joint between wiping sleeve and lead sleeve of cable. Remove wiping sleeve pipe plug during this operation to eliminate internal pressure	Demonstrate this verticle wipe	
15. Attach standpipe to filling hole		
a. Standpipe should be heated before pouring oil through it		
b. Fill until the oil comes out of the top vent hole		
c. Allow time for the oil to cool		
d. Remove standpipe		
e. Coat the threads of the filling hole and vent plugs with gasket compound and tighten securely		
16. Retighten all joints securely Brighten contact surface on capnut stud with sandpaper and attach aerial log	Show the completed splice	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application:		
A. Questions (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	
1. Make a termination splice in accordance with Job Sheet JS-1.3.3.1	Hand out splicing tools and materials	Student will follow instructions in Job Sheet JS-1.3.3.1
	Supervise and assist as necessary	
	Stress safety factors	
	Test the student's splice	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Terminating VCL power cable	Don't introduce new material	
1. Outdoor shielded	Hold all questions until completion of summary	
2. Stress cones		
B. Terminating procedures		
1. Measure and mark cables		
2. Remove insulation and sheath		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Install connector		
4. Build stress cone		
5. Assemble pothead with cable		
6. Fill pothead with oil		
7. Install plugs securely		
8. Brighten contact surface		
V. Criterion Test:	Hand out splicing tools and materials	
A. Make a termination splice in accordance with Job Sheet JS-1.3.3.1	Stress safety factors Inform students they will be performing without supervision Grade student on go-no go basis Have student dismantle his splice and salvage materials after test	Student will demonstrate knowledge by performing splice
VI. Assignment:		
A. Read and study Underground Systems Reference Book, 1957 Ed., chapter 9	Ask oral questions on reading assignment	Participate by answering oral questions

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIAN/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.4 CROSS-LINKED POLYETHLENE INSULATED CABLE SPLICING

TIME ALLOCATION: Classroom 3 Hours
Practical 40 Hours

INSTRUCTIONAL MATERIALS:

1. Text:

   a. Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio

2. Reference:

   a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute

   b. Design and Engineering Manual, 3M Electro-Products Division

3. Training Aids:

   a. Display Boards:

      (1) XLP Shielded Cable, Single Conductor, Straight Splice Cut-away

      (2) XLP Unshielded Cable, Single Conductor, Straight Splice Cut-away

      (3) XLP Cable, Three Conductor, Straight Splice Cut-away

   b. All-Tape Splice Kit - CE "C" 1.3.4.1J

   c. 3M "Scotchcast" Print E-MPD-3 - CE "C" 1.3.4.2J

   d. "Collyer" Print No. SR-4: Mine Power Cable 5-15 kv, Straight Splice (Shielded) 3/C - CE "C" 1.3.4.3J

4. Training Aids Equipment: None

5. Tools and Equipment:

   a. Cable Splicers Tool Box

   b. Hacksaw

   c. Sharpening stone

   d. Soldering coppers

e. Compression tools, Burndy

   (1) Hytool MY29-3

   (2) Hypress Y34A (hydraulic)

   (3) Hypress Y35 (hydraulic)

f. Cable stripping tools

   (1) PLM type SQ, various sizes

   (2) Greenlee, Numbers 1805 and 1905

g. Cable pencilling tool, PLM type PT (various sizes)

h. Cable slicer

i. Resin pressure gun, Scotchcast E-4A

6. Materials:

a. Cable, Cross-Linked Polyethlene, 5 kv

   (1) Shielded, 1/C, AWG #4/0

   (2) Unshielded, 1/C, AWG #4/0

   (3) Shielded or unshielded, 3/C, AWG #4/0

b. GE Uni-Kit No. SS 8-B or equal

c. Connectors

   (1) Burndy Hylink YS28 or T&B 54512 (4/0)

d. Tapes

   (1) Semi-conducting, "Scotch" 13 or equal

   (2) High voltage, "Scotch" 23, GE 8380, Bishop Bi-seal (Tomic No. 3T) 9G5970 00931 4491

   (3) Shielding Braid, "Scotch" 24, Tomic No. 15T

   (4) Spacer, Scotch No. P-3, 9G 5975 00909 2053

   (5) Anhydrious, "Scotch" No. P-4

   (6) Vynal Plastic, 1" X 108', "Scotch" #88 - 9G 5970 00926 7220

e. Injection Fitting "Scotchcast" P-1 9G 5975 00992 3589

f. Nozzle for E4 resin pressure gun, P-5 9G 5975 00992 3590

g. Resin, "Scotchcast" electrical insulating, No. 4, sizes "B" & "C" 9G 5970 00814 1788

h. Abrasive paper, Grit 320, 5350-00229-3086

i. Solder, wire SN-50 3439 273 1637

j. Trichlorethylene

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Rubber insulation-rubber sheathed cable, single conductor - straight splice - 2.0 hours.

   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours.

   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours.

   e. XLP shielded cable, single conductor - straight splice - 3.0 hours.

   f. XLP unshielded cable, single conductor - straight splice - 4.0 hours.

   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours.

   h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours.

   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours.

   These splices will be constructed in accordance with Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.4 Upon completion of this topic the student will be able to construct the following splices in 5 kv Cross-Linked Polyethlene insulated cables utilizing the appropriate tools and materials in accordance with Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio and Job Sheet as indicated by each type cable.

1. XLP shielded, single conductor, AWG #4/0 power cable - CE "C" 1.3.4.1J
2. XLP unshielded, single conductor, AWG #4/0 power cable - CE "C" 1.3.4.2J.
3. XLP shielded or unshielded, three conductor, AWG #4/0 power cable - CE "C" 1.3.4.3J.

The splices will be required to withstand an acceptance test of 27.6 kv for 15 minutes on shielded cable and 28.8 kv for 15 minutes on unshielded cable in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct the following splices in 5 kv Cross-Linked Polyethlene insulated cables utilizing the appropriate tools and materials in accordance with Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio and Job Sheets CE "C" 1.3.4.1J, CE "C" 1.3.4.2J, and CE "C" 1.3.4.3J. The splices will be required to withstand an acceptance test of 27.6 kv for 15 minutes on shielded cable and 28.8 kv for 15 minutes on unshielded cable in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

Read and study Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio Chapter III.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise a. How? b. When?	
II. Presentation:		
A. Cable Preparation	Make ready the T/A listed for this lesson	
1. Train cable into position, determine splice location and cut into proper length	Hand out text and job sheets for this lesson	
	Hand out manufacturers instruction for splice kit	Note page 3 & 5, Table One and splice diagram
	Note the amount of jacket to be removed	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Determine length of sheath opening		
3. Clean cable sheath at points of tape or resin contact in splice area		
a. Consider no cable sheath as clean regardless of how it looks		
b. Use a knife held approximately perpendicular to cable and pull as a scraper or use a non-conductive abrasive cloth	Use abrasive cloth and trichlorethylene to clean the sheath	
c. Use only approved types of cleaning solvent such as trichlorethylene or similar with a lint free cloth to wipe the cable sheath clean		
4. Remove jacket (sheath)	Remove jacket as per outline - to expedite the demonstration have various phases of the splice prefabricated	
a. Make circular score about one-half (½) way through its thickness		
b. Make longitudinal cut from one end of cable back to the score. Care must be taken not to cut shielding or insulation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. After removing jacket, all bedding tapes should be removed back to the jacket		
5. Remove metallic shielding (if used)	Demonstrate the use of tape (glass) and/or the use of a hose clamp to aid in the removal of the shielding. NOTE: If not tape type, wrap 1½ layers of copper mesh over wire shielding	
a. Wrap glass cloth tape around shielding the required distance from cable jacket, usually one inch		
b. Tin and solder area between glass tape and sheath to hold shielding in place		
c. A ground strap of braid may be attached during the soldering process	Solder the shielding	
d. Hold a sharp knife against shielding at point of removal		
e. Pull shielding away from cable insulation against the blade of the knife		
(1) Care must be taken not to nick the cable insulation		
(2) Be sure no sharp edges point down at cable insulation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(3) Shielding may be rolled back at edge to eliminate sharp points	When semi-conducting tape is removed fold back over the shielding tape	
f. Remove all traces of semi-conducting material from the exposed insulation back to within approximately one-quarter inch from the metallic shielding		
(1) Rubber insulation is best cleaned by scraping with a knife and then buffed with non-conductive abrasive cloth		
(2) Polyethylene may only need to be buffed with an abrasive cloth		
(3) Only approved solvents should be used on the sheaths		
6. Remove and pencil insulation	Have student measure the connector to determine the dimension of cut-back	Measure the connector

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Remove insulation from end of conductors for one-half the connector length plus an additional length as required by the splice drawing to allow room for a smooth transition between connector and the penciled insulation	Question students - dimension	
b. Polyethylene insulation can best be removed with a stripping tool, but when not available, it must be ring cut with a knife and stripped as a rubber cable	Show the use of strippers and penciling tools. A penciling tool may be used to remove all of the insulation	
c. Extreme care must be used when removing insulation not to nick conductor		
d. Insulation may be penciled with either a knife and abrasive cloth or a mechanical penciling tool		
e. The penciled area must be smooth and uniform		
	NOTE: Use of Burndy and T&B indent and crimping tools previously taught	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Connector Installation		
1. Proper choice of connector is an integral and essential part of making a reliable splice	An EEI approved solder connector may be used, but warn the splicers to use minimum heat, and extreme care not to melt the tapered insulation	
2. Connectors can be put into two general classifications:		
a. The metal in the connected conductors		
(1) Copper connectors for copper		
(2) Aluminum connectors for aluminum		
(3) Special connector required to connect copper to aluminum		
b. The design of the connector may be:		
(1) Solder - sweated type		
(2) Crimp type		
(3) Thermoplastic insulated cables must be joined with crimp connectors only		

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

3. Clean ends of conductors by scraping and apply sterine flux - and connect by:

   a. Installing solder connectors

      (1) Slip over one conductor

      (2) Insert end of the other conductor into connector until it butts first conductor squarely

      (3) Center over conductors with slot on top

      (4) Tightly press connector around conductor with pliers

      (5) Use two solder ladles, one to pour hot solder and one to catch overflow

      (6) Pour hot solder over connector and into slot until connector and conductor are hot enough to make solder flow freely

      (7) Apply flux and allow to run into slot and through strands

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(8) Alternate pouring and applying flux until connector is tinned to a bright shiny coat approximately 5 or 6 times		
(9) Allow solder to cool in the ladle. Pour until solder becomes plastic and fills slot, while tapping the connector		
(10) Smooth off the burrs with dry cotton tape while the connector is still hot and dress with a small wipe cloth		
(11) While cooling, polish the connector with a loop of 1" cotton tape and small wipe cloth	Polish connector with abrasive cloth and file as required	
b. Installing crimp type connectors		
(1) Thoroughly clean inside of connector and slip over one of the pre-cleaned conductors		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Insert end of the other conductor into the connector until the ends butt squarely		
(3) Center connector over conductor ends		
(4) Crimp with either hand or hydraulic crimping device		
(5) Indents in connector must be filled to reduce stress and make joint electrically round	NOTE: "Scotch" 13 semi-conducting tape is non-vulcanizing and is compatible with all rubber and thermoplastic insulations	
(6) Indents can be filled by pushing semi-conducting tape into them and wrapping the tape tightly over the edge of the connector		
C. Replacing Insulation		
1. Resin type joints, (7.5 kv cable and below)	Refer to 3M Print E-MPD-4 in text	Student follows the instructions with the print

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Apply spacer tape (Scotch P-3)	NOTE: On shielded splices do not extend the P-3 spacer over the shielding or semi-conducting tape	
(1) Level wind		
(2) Do not stretch		
(3) Taper smoothly		
b. Apply electrostatic shield	This step only for shielded cable	
(1) Apply a tightly wrapped layer of "Scotch" 13 tape over the cable semi-conducting tape and ¼" onto the metallic shield at each end	NOTE: Refer to text - Splicing and Termination Theory and Practice, Ch. I, Section III, Insulation Shielding, page 10 (The principal functions of an insulation shield are:)	
(2) Wrap one layer, one-half lapped of "Scotch" #24 shielding tape over the entire splice ending ½" onto the metallic shield of each cable		
c. Attach bonding wire		
(1) Wrap spirally around splice and solder to the other cable shield		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Build dam with insulation putty below and above the ground wire	Refer the students to appendix II, page 46D, step 5 for illustration of dam. The ground braid should be filled with solder for ½" on each side of the dam	Students note how the dam is constructed
d. Apply outer sheath		
(1) Wrap spacer tape over entire joint extending 3" onto cable jacket or sheath		
(2) Build up according to drawing or between ¼" and 3/8"		
(3) Level wind		
e. P-1 injection fitting installation		
(1) Position P-1 fitting near one end of splice		
(2) Position the spout for maximum convenience when using the resin pressure gun		
f. Plastic tape envelope installation		

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

(1) Using 1½" scotch brand #33 electrical tape - start the first strip of tape on one side of the injection fitting and continue half-lapping beyond the end of the spacer tape

NOTE: This tape should be 1" to 1½" inwidth. "Scotch" #88 is in Federal Supply system - 1" X 108' 9G 5970 00188 6478, $.85 P/Rl. Open purchase $3.02 P/Rl

(2) Start the second strip of tape on the other side of the injection fitting, continue half lapping over the other end of the spacer tape

(3) When wrapping, pull this vinyl tape tightly so that it will conform to the spacer tape build-up

(4) If wrinkles appear in the tape envelope possible resin leaks may appear

g. Restricting tape installation

(1) Vinyl tape will stretch under pressure and must be restricted

(2) Using 1" P-4 restricting tape, firmly wrap two half-lapped layers over the plastic tape envelope

(3) Start at one end of splice, wrap to the other end, and return to the starting point

(4) Restricting tape may be removed after splice has cured

h. Vent hole provisions

(1) Before resin injection, a vent hole must be punctured through envelope at end farthest from injection fitting

(2) Care must be taken not to puncture insulation

(3) Vent parallel with axis of the cable and 3" from the end of the tape

(4) After the resin is injected in the splice and appears at this vent hole, a

second vent is made at the other end of splice before continuing the resin injection

(5) These vents drain off all air and eliminate voids in the splice

i. Resin saturation

  (1) Prepare resin

    (a) Mix two parts together

    (b) Apply injection nozzel (P-5) to the bag

    (c) Slide the bag of resin into the barrel of the E-4 resin pressure gun

    (d) Pull the nozzle through the cap and lock in place

  (2) Attach resin pressure gun by screwing injection nozzle into the injection fitting (P-1)

    (a) Inject resin into splice until droplet of resin appears at far end, then tape

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(b) Make the second vent hole near the end of the splice		
(c) Continue to inject resin until droplet appears at second vent hole		
(d) Release gun pressure and remove gun		
(e) Tape the second vent hole		
2. All tape splice		
a. Apply ozone resistant tape		
(1) Half-lapped (50% overlap)		
(2) Thickness over connector and semi-conductor tape to equal:	Take a caliper reading over the connector	
(a) Three times factory applied insulation or -	Explain what the overall width will be and that several manufacturers specifications do vary from 1½ times to three times the factory applied insulation	
(b) Thickness specified on the drawing for that splice		

(3) Taper down to the edge of the factory semi-conducting tape on each end

(4) Suggested tapes are:

(a) Scotch #23

(b) GE #8380

(c) Bishop #30 (Tomic No. 3T)

NOTE: #23 OP - $1.38
FSN 9G5970-00931-4491 $1.27
3T - $1.63

D. Shielding and Covering of Splice

1. Replace factory semi-conducting tape with one layer half-lapped tape (if required)

a. Suggested tapes are:

(1) Scotch #13

(2) Bishop #17 (Tomic 17T) EPR shielding tape

2. Replace factory shielding tape with one layer of copper mesh tape half-lapped. "Scotch" #24, Tomic No. 15T

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Solder copper mesh tape to factory shielding and spot solder along tapered areas		
4. Solder ground strap across splice to each shielding allowing enough on one end to reach system ground		
5. Solder ground strap where it leaves splice to prevent the infiltration of water into the joint	Demonstrate this at splice position. Not in the classroom	
6. Apply "Scotchfil" 1½" from cable sheath on end of ground strap - above and below the strap		
7. Cover entire splice plus 1½" of sheath with "Scotch" #33 or equal		
E. Special Conditions May Exist Where Extra Sheath Protection Is Required	NOTE: Instructions to provide this extra protection can be found on "Collyer" spec. SP-1, Step 6	Students refer to step 6 in "Collyer" specs. SP-1
F. Connect ground wire or strap solidly to a direct ground		
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Practical Application Period	Inform students this segment will be taught in the shop area	
1. Make a straight splice in accordance with Job Sheet JS-1.3.4.1	Hand out splicing tools and materials as required for each splice	Student will follow instructions in Job Sheets listed for each splice
2. Make a straight splice in accordance with Job Sheet JS-1.3.4.2	Supervise and assist as necessary	
3. Make a straight splice in accordance with Job Sheet JS-1.3.4.3	Stress safety factors As students complete each splice, test it	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Cable Preparation	Do not introduce new material	
1. Train cable into position	Have students to hold all questions until completion	
2. Remove jacket (sheath)		
3. Remove shielding		
4. Remove and pencil insulation		
B. Connector Installation		
1. Choice of connector		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Classifications		
3. Solder connector, installation of		
4. Crimp connector, installation of		
C. Replacing Insulation		
1. Resin type joints, (7.5 kv cable and below)		
2. All tape splice		
D. Shielding and Covering of Splice		
E. Special Conditions		
F. Grounding		Ask questions after completion of summary
V. Criterion Test:	Hand out splicing tools and materials as required for each splice	Student will demonstrate knowledge by performing three straight splices
A. Make a straight splice in accordance with Job Sheet JS-1.3.4.1	Stress safety factors	
B. Make a straight splice in accordance with Job Sheet JS-1.3.4.2	Inform students they will be performing without supervision	
C. Make a straight splice in accordance with Job Sheet JS-1.3.4.3	Grade student on go-no go basis as he completes each splice	Position each completed splice on test frame

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	Have student dismantle his splices and salvage materials after last test	
VI. Assignment:		
A. Read and study Splicing and Termination Theory and Practices, Chapter III	Ask oral questions on reading assignment	Participate by answering oral questions

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.5 TERMINATION WITH XLP 5 kv CABLE

TIME ALLOCATION: Classroom 1 Hour
Practical 6 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
   a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
   b. Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio
2. References: None
3. Training Aids:
   a. Scotch "K" Tape Termination Kits - CE "C" 1.3.5.1J
   b. Brochures:
      (1) Scotch K Tape Termination Kits, E-MKTB-1 (16-25) PD, 3M Company
      (2) Silicone Tape Prevents Flashover In Salt Atmosphere, E-MAR/1 (91.05) R, 3M Company
4. Training Aids Equipment: None
5. Tools and Equipment:
   a. Cable Splicers Tool Box
   b. Hacksaw
   c. Sharpening stone
   d. Soldering coppers
   e. Compression tool
   f. Cable stripping tool
   g. Cable penciling tool
   h. Cable slicer
6. Materials:
   a. Cable, Cross-Linked Polyethylene, 5 kv, shielded, 1/C, AWG #4/0

b. "K" Tape Termination Kit, 3M Company

c. Lug, Burndy - YA28, AWG 4/0

d. Solder, wire SN-50

TERMINAL OBJECTIVE

Supported entirely by this lesson topic.

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Rubber insulation-rubber sheathed cable, single conductor - straight splice - 2.0 hours.

   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours.

   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours.

   e. XLP shielded cable, single conductor - straight splice - 3.0 hours.

   f. XLP unshielded cable, single conductor - straight splice - 4.0 hours.

   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours.

   h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours.

   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours.

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3 series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.5 Upon completion of this topic the student will be able to construct a termination splice in 5 kv, single conductor, AWG #4/0, Cross-Linked Polyethlene insulated power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3.5.1J without deviation. The splice will be required to withstand an acceptance test of 27.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a termination splice in 5 kv, single conductor, AWG #4/0, Cross-Linked Polyethlene insulated power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Termination and Splices - Theory - Practice PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3.5.1J without deviation. The splice will be required to withstand an acceptance test of 27.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Chapter 9, Section D.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise a. How? b. When?	
II. Presentation:	Make ready the T/A listed for this lesson	
A. Terminating Shielded Cable	Hand out texts, Job Sheet, and Brochures for this lesson	
1. Theory of terminations	Refer student to text, Splicing and Termination Theory and Practice, Ch. V, Page 49	Student refers to text and follows instruction
a. Shielding provides stress relief		
b. Shielding provides ground return		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Termination results in:		
(1) Change in dielectric field		
(2) Results in stress concentration		
d. Remedy	Show display of stress cones	
(1) Stress cones		
(a) Preformed		
(b) Tape constructed		
e. Tracking		
(1) The cable shielding in a termination is cut off and the conductor, which is at phase potential, is left exposed		
(2) Surface failure results from the progressive degradation of the insulation surface		
f. External flashover		
(1) Damage by -		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Lengthen creepage path		
(3) Increase insulation (hiding grounded stress cone)		
(4) Flashover to ground causes no damage		
g. Seal conductor and replace cable jacket	Hand out to each student the manufacturer's instructions from the splice kit	Student learns the application and limitations of the "K" tape type terminations
B. Splicing Kit		
1. Design		
a. Voltage		
(1) 5 - 15 kv		
(2) Dimensions for		
b. Location		
(1) Indoor		
(2) Outdoor (use Scotch #70)		
2. Contents		
a. Manufacturer's instructions		
(1) Procedures		

[illegible]TLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Material list		
C. Instructions		
1. Prepare cable		
a. Train cable into position		
b. Cut to proper length	Question class for the various dimensions	Provide the dimensions and learn steps from the mfg. instructions
c. Thoroughly clean cable jacket		
2. Remove Sheath		
a. Outer jacket and filler tapes	NOTE: The following procedures need not be demonstrated if the students have all completed the preceding XLP splices	
b. Shielding tapes or wires		
c. Install ground strap		
(1) Over shielding tape		
(2) Place "Scotch" 24 shielding tape over wire type shield before strap		
3. Remove semi-conducting materials and Insulation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVIT
a. Leave ¼" of semi-conducting tape exposed beyond the metallic shielding or ground strap in the case of wire type shielding		
b. Remove cable insulation from end of conductor for ½" plus depth of terminal lug barrel or length of exposed conductor required		
c. Clean entire area of prepared cable insulation with trichlorethylene		
4. Pencil insulation and seal cable end		
a. Pencil for distance "B"	Question: What is dimension "B"?	
b. Buff taper with non-conductive abrasive cloth		
c. Install connector		
5. Apply semi-conductive tape		
a. Apply two half-lapped layers of semi-conducting tape		
b. Begin and end taping at front edge of ground strap.		

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIVITY

CAUTION: Do not wrap semi-conducting tape more than ½" onto the cable insulation

   c. Fill indents with "Scotch #13

   d. Level wind No. 13 tape from 1/16" on edge of pencil onto conductor seal

6. Apply stress control tape

   a. Starting at the edge of the ground strap, apply "Scotch" No. 2220 stress control tape, liner side toward cable, removing liner as tape is applied

   b. Apply a distance 2" beyond No. 13 tape

   c. Leave an even front edge and continue to half-lap the tape back on itself ending at the ground strap

7. Apply outer sheath

   a. Tightly half-lap high-voltage tape over "pencil" and

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
semi-conducting tape extending onto terminal lug or exposed conductor seal and build up to the level of cable insulation		
b. Wrap one half-lapped layer of high voltage tape for 2" along the cable jacket, starting at point where ground strap is attached to the cable metallic shielding		
c. Wrap one half-lapped layer of high voltage tape 2" along grounding wire, bend wire back along jacket for 1", then bend away from cable		
d. Wrap two half-lapped layers of high voltage tape 2" onto cable jacket to 1" beyond previously applied stress control tape		
e. Apply one half-lapped layer of vinyl tape over the high voltage tape, extending 1" onto cable jacket and onto conductor lug or exposed conductor	Display completed splice	
8. Outdoor and contaminated areas		
a. If possible connect termination to final position		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Apply tracking protection		
c. Note page (8) of instructions for "K" tape terminations	Refer students to page 8 of instruction and distribute special 3M Company Brochure regarding "Tracking"	Students refer to page 8
III. Application:		
A. Questions (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	
1. Make a termination splice in accordance with Job Sheet JS-1.3.5.1	Hand out splicing tools and materials	Student will follow instructions in Job Sheet JS-1.3.5.1
	Stress safety factors	
	Supervise and assist as necessary	
	Test the student's splice	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Terminating Cable		
1. Theory of terminations	Do not introduce new material	
B. Splicing Kit	Hold all questions until completion of summary	Ask questions after completion of summary

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Instructions		
V. Criterion Test:	Hand out splicing tools and material	
A. Make a termination splice in accordance with Job Sheet JS-1.3.5.1	Stress safety factors	Student will demonstrate knowledge by performing splice
	Inform students they will be performing without supervision	
	Grade student on go-no go basis	Position completed splice on test frame
	Have student dismantle his splice and salvage materials after test	
VI. Assignment:		
A. Read and study Underground Systems Reference Book, 1957 Ed., Edison Electric Institute, Ch. 9, Sec. D	Ask oral questions on reading assignment	Participate by answering oral questions

247

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.6 STRAIGHT TRANSITION SPLICE W/OIL STOP, 5 kv, 1/C, XLP TO VCL

TIME ALLOCATION: Classroom 1 Hours
Practical 24 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
   a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. Reference: None
3. Training Aids:
   a. Display Board - Splicing Steps of a Transition Joint
   b. Straight Transition Splice W/Oil Stop, 5 kv, 1/C, XLP to VCL - CE "C" 1.3.6.1J
4. Training Aids Equipment: None
5. Tools and Equipment:
   a. Cable Splicers Tool Box
   b. Compression tool for connector
   c. Hacksaw/cable splicers saw
   d. Sharpening stone
6. Materials:
   a. Cable, 5 kv, 1/C, AWG #3/0
      (1) Cross-linked polyethlene, 6' per student
      (2) Varnished-cambric-lead sheathed, 6' per student
   b. Connector, split tinned AWG 4/0
   c. Lead sleeving, 2½" X 20"
   d. Aux. lead sleeve 5"
   e. Tapes -
      (1) Varnished-cambric (dry) 3/4"
      (2) "Fibermat" II or III, ¼ & ½"
      (3) Polyester-glass, "GE" Versa Fab
   f. Rubber, "Bishop" No. W963, 3/4"
   g. Vinyl, 3/4"

h. Arc and fire proofing tape, "Scotch" 7700

i. Glyptal lacquer, GE 1201

j. Oil filling compound

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 5 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Rubber insulation-rubber sheathed cable, single conductor - straight splice - 2.0 hours.

   b. Rubber insulation-lead sheathed cable, single conductor - straight splice - 7.0 hours.

   c. Rubber insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

   d. Varnished cambric insulation-lead sheathed cable, single conductor - termination splice - 4.0 hours.

   e. XLP shielded cable, single conductor - straight splice - 3.0 hours.

   f. XLP unshielded cable, single conductor - straight splice - 4.0 hours.

   g. XLP shielded or unshielded cable, three conductor - straight splice - 11.0 hours.

   h. XLP shielded or unshielded cable, single conductor - termination splice - 2.0 hours.

   i. XLP shielded or unshielded to varnished cambric cable, single conductor - straight transition splice - 11.0 hours.

   These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.6 Upon completion of this topic the student will be able to construct a straight transition splice in a 5 kv, single conductor, AWG #4/0, cross-linked polyethlene insulated power cable to a 5 kv, single conductor, AWG #4/0, varnished-cambric insulated-lead covered power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.6.1J without deviation. The splice will be required to withstand an acceptance test of 27.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a straight transition splice in a 5 kv, single conductor, AWG #4/0, cross-linked polyethlene insulated power cable to a 5 kv, single conductor, AWG #4/0, varnished-cambric insulated-lead covered power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.6.1J without deviation. The splice will be required to withstand an acceptance test of 27.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 9-13 through 9-18

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise a. How b. When	
II. Presentation:	Make ready the T/A listed for this lesson	
A. Construction of a 5 kv Transition Splice	Handout text and Job Sheet for this lesson	
1. Cable preparation a. Arrange the cables into the desired final position (1) Avoid severe bending - use correct bending radius	Explain these instructions are complete for a typical cable installation. A print can be sketched by student	Student draws a sketch of splice and notes dimensions

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Allow slight overlap of ends	Use the display board to expedite this lecture, many steps are repetitious of previous XLP & VCL splices	
b. Cut cables to butt squarely together at desired centerline of splice	The cable on one side of centerline must be straight enough to allow for sliding the sleeve back while making the joint	
2. Preparation of lead sleeve	NOTE: Step (12); the student can accomplish this step now and should be so informed	
a. Scrape both ends of the sleeve for 3 or 4 inches with a rasp or shave hook		
b. Apply sterine flux to cleaned portions		
c. Beat down one end of the sleeve to a point slightly larger than cable diameter		
d. Slide beat down end over one end of the cable		
3. Removing the lead sheath		
a. Measure and mark the sheath at a distance "A" from lead cable end. For a 4/0 cable	Have student find the dimension from a previous VCL 5 kv print. The print number is "Collyer" SV-1	Student locate dimension and marks on his print

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
"A" = 4½" NOTE: This includes one half the connector length plus the usual ½"		
b. Ring the sheath at the mark with a sheath knife and tinners hammer	CAUTION: Ring should be approximately one-half through sheath "Do not damage the insulation"	
c. Clean the lead sheath for 3" beyond the ring with a shave hook and apply sterine flux		
d. Apply paper pasters on ends of cleaned area so as to have 1 1/2 inches of exposed cleaned cable sheath. The first paster should be ½" from the cable ring		
e. Tin the cleaned portion of cable sheath with wiping solder. Usual procedures to be followed		
f. Remove paper pasters		
g. Slip the sheath up to the score being careful not to injure the insulation using a chipping knife and tinners hammer		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
h. Tear the lead sheath off in such a manner that a natural bell is formed at the end of the sheath		
4. Remove jacket on cross-linked polyethylene cable		
a. Remove 5" of jacket by ringing and splitting with shoemakers knife	Have the students find this dimension print "Collyer" SP-1	Student locate dimension and mark on print
5. Remove metallic shield from the cable leaving one inch of shield from the jacket	Explain to students that if the cable has concentric shield wires these will be prepared as per instructions in General Electric Publication No. WC-3910	
6. Remove the semi-conducting material to ½" from the metallic shielding		
7. Pencil the jacket end 1/4" using a sharp knife	CAUTION: All semi-conducting material must be removed from the insulation to prevent the splice from breaking down	
8. Half lap two or more layers of "ozone" resisting rubber tape over the end of the jacket for six inches. "Scotch" 23 or equal		
9. Clean and tin a 5" auxiliary sleeve using correct procedures	This step should have been accomplished when preparing the sheath of the cable	

OUTLINE OF INSTRUCTION | INSTRUCTOR ACTIVITY | STUDENT ACTIV

10. Tightly fit the auxiliary sleeve over the "ozone" resistant tape

11. Apply copper mesh tape from the metallic shield to the auxiliary sleeve (shielded cables).

    a. Half lap the copper mesh tape

    b. Spot solder the mesh tape to the auxiliary sleeve and metallic shielding using a hot soldering copper and 50/50 wire solder

CAUTION: Do not overheat insulation as it will cause failure of the splice

12. Prepare cable ends for connector

    a. Mark ends one half the length of the connector plus ½".

    b. To prevent the varnish-cambric factory insulation from unwinding wrap with dry varnish-cambric tape and tie off

    c. Cut the insulation squarely down to the conductor with shoemakers knife or taper knife at the mark

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Pencil insulation for a distance of 3/4" using correct procedures (1) Sharp taper knife for V.C. cable (2) PLM pencil tool for the XLP cable	NOTE: A varnished-cambric insulated cable may be penciled after the solder type connector is installed. This can help to protect insulation from heat of solder	
13. Installing connector		
a. Polish exposed conductors and connector thoroughly using non-conducting abrasive cloth. Wipe with a lint free rag and solvent		
b. Install the split-tinned connector, solder, and polish thoroughly removing all projections	Wrap cotton tape around the ends of both cables to protect from heat of solder	
14. Preparation of splice (joint) for insulating		
a. Using non-conducting abrasive cloth roughen and clean the insulation on the non-lead covered cable, then wipe with lint free rag		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Pencil and/or remove the dry varnish-cambric tape and one layer of factory insulation from the lead covered cable	State that this will eliminate any foreign material that may have accumulated on the insulation	
15. Insulating the splice (joint)		
a. Build an oil stop on the non-lead covered cable (XLP) by putting (4) one-half lapped layers of varnished silk tape with a coating of lacquer, enamel or oil stop compound between each layer. The oil stop is to go from the auxiliary sleeve to the middle of the connector	NOTE: Allow the compound to dry before each layer of tape	
b. Fill the space between connector and lead covered cable insulation with ½" wide oil-immersed varnish-cambric tape	CAUTION: Avoid air voids in your taping. Explain because this is the first use of oil-immersed V.C. tape	
c. Tape over the connector and pencil with ½" oil-immersed V.C. tape up to the level of the factory applied insulation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Build up splice with 3/4" oil-immersed varnish-cambric tape to two (2) times the factory applied insulation	NOTE: Apply tape with enough tension to eliminate voids but not enough tension to crack the varnish on the tape	
16. Install and wipe the lead sleeve		
a. Center the lead sleeve over the splice and beat down the ends tightly on the cable sheath		
b. Apply paper pasters on the sleeves and sheath		
17. Seal the cross-linked polyethylene cable jacket to the auxiliary sleeve		
a. Apply two ½ lapped layers of "ozone" resistant rubber tape over the exposed end of the auxiliary sleeve on to the cable jacket to form a water tight seal	These tapes are satisfactory. "Scotch" #23 G.E. #8380,"Tomic" #W-963 EPR, Plysafe	Student records on his print
b. Apply two ½ lapped layers of plastic tape - "Scotch" 33 over the rubber tape		
c. Apply two layers of friction tape over the plastic tape		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
18. Filling the splice		
a. Make a "V" shaped hole at each end of the lead sleeve with a cable sheath knife and tinners hammer	CAUTION: DO NOT DAMAGE THE INSULATION	
b. Heat the filling compound to the designated pouring temperature on a furnace	Never exceed the manufacturers maximum temperature	
c. With the splice slightly tilted pour the compound in the lower "V" shaped knotch		
d. Solder the holes closed with 50/50 solder using a soldering copper	CAUTION: Observe all safety precautions	
19. Test the splice		
20. Securing joint and cable	Explain that these steps must be accomplished in the field but may be omitted in class on this joint	
a. Bond cable to other cables and ground		
b. Apply corosion or fire protection tapes		
c. Attach identification tag or mark cable		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application:		
A. Questions (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	Student will follow instructions in Job Sheet JS-1.3.6.1
1. Make a straight transition splice in accordance with Job Sheet JS-1.3.6.1	Hand out splicing tools and materials	
	Stress safety factors	
	Supervise and assist as necessary	
	Test the student's splice	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Construction of a 5 kv Transition Splice	Do not introduce new material	
1. Cable preparation	Hold all questions until completion of summary	
2. Preparation of lead sleeve		
3. Removing the lead sheath		
4. Remove jacket on cross-linked polyethylene cable		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
5. Remove metallic shield from the cable leaving one inch of shield from the jacket		
6. Remove the semi-conducting material to ½" from the metallic shielding		
7. Pencil the jacket end 1/4" using a sharp knife		
8. Half lap two or more layers of "ozone" resisting rubber tape over the end of the jacket for six inches. "Scotch" 23 or equal		
9. Clean and tin a 5" auxiliary sleeve using correct procedures		
10. Tightly fit the auxiliary sleeve over the "ozone" resistant tape		
11. Apply copper mesh tape from the metallic shield to the auxiliary sleeve (shielded cables)		
12. Prepare cable ends for connector		
13. Installing connector		
14. Preparation of splice (joint) for insulating		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
15. Insulating the splice (joint)		
16. Install and wipe the lead sleeve		
17. Seal the cross-linked polyethylene cable jacket to the auxiliary		
18. Filling the splice		
19. Test the splice		Ask questions after completion of summary
20. Securing joint and cable		
V. Criterion Test:	Hand out splicing tools and materials	Student will demonstrate knowledge by performing splice
A. Make a straight transition splice in accordance with Job Sheet JS-1.3.6.1	Stress safety factors	
	Inform students they will be performing without supervision	
	Grade student on go-no go basis	Position completed splice on test frame
	Have student dismantle his splice and salvage materials after test	
VI. Assignment:		
A. Read and study Underground System Reference Book, 1957 Ed., Edison Electric Institute, pages 9-13 through 9-18	Ask oral questions on reading assignment	Participate by answering oral questions

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.7 BRANCH SPLICE, 15 kv, VCL, AWG #4/0

TIME ALLOCATION: Classroom 1 Hours
Practical 24 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
    a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. References: None
3. Training Aids:
    a. Display Board - 15 kv, VCL Splice "Cut-away"
    b. 15 kv, Single Conductor, VCL Cable, Grounded, Branch Splice - CE "C" 1.3.71.J
4. Training Aids Equipment: None
5. Tools and Equipment:
    a. Cable Splicers Tool Box
    b. Hacksaw
    c. Sharpening stone
    d. Pliers, eagle beak
    e. Lead sleeve slitter
    f. Melting pot (solder)
        (1) Electric
        (2) Cast iron
    g. Gas furnace (butane)
    h. Windshield
    i. Cable slicer (hand)
    j. Oil pot, funnel, and oil pan
6. Materials:
    a. Cable, 15 kv, VCL, AWG #4/0, 1/C, 9' per student
    b. Connector, split tinned, 4/0, Branch
    c. Tapes

(1) Varnished-cambric, oil immersed, Irvinington ½" and 3/4" No. 2511

(2) Varnished polyester web fibermat 1/4" and 3/4" No. 2551

(3) Cotton

(4) Muslin

d. Lead crotch piece (A-1), for branch joint

e. Insulating oil No. 219

f. Lead sleeve, 3½" X 18"

g. Abrasive cloth (non-conducting)

h. Solder, 40/60 wiping

i. Solder, 50/50 seam

j. Sterine candles

k. Paper pasters

l. Wiping rags

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

    a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

    b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours.

    c. XLP shielded cable, three conductor - termination splice - 7.0 hours.

    d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours.

    These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Termination and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC

High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.7 Upon completion of this topic the student will be able to construct a branch splice in a 15 kv varnished-cambric insulated-lead sheathed (VCL), AWG #4/0 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.7.1J without deviation. The splice will be required to withstand an acceptance test of 93.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a branch splice in a 15 kv varnished-cambric insulated-lead sheathed (VCL), AWG #4/0 power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.7.1J without deviation. The splice will be required to withstand an acceptance test of 93.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK - None

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
	State topic objective	
	Explain the method(s) to be used	
	Topic Criterion Exercise a. How b. When	
II. Presentation:	Make ready the T/A listed for this lesson	
A. Cable, 15 kv	Hand out texts, and Job Sheets for this lesson	
1. Avoid contamination		
a. Moisture	Impart that special procedures are required in the construction of high voltage joints	
(1) Condensation		
(2) Perspiration		
b. Wiping rags		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Insulate without interruption		
d. Flush with oil		
2. Prevent voids in the insulation	Oil soaked cotton yarn or paste of dry sawdust and petrolatum may be used to fill voids. Have this available for students	
a. Prevents ionization		
b. Fill voids		
c. Baste tape layers		
3. Insulating tape		
a. Joints above 7.5 kv tape is furnished in cans packed in oil		
b. Open can when splice has been made. This helps to prevent contamination	When a splice is made for training, limit the number of cans opened at one time. Student will share tape from one can	
c. Branch joints		
(1) Voids filled		
(2) Voids not filled		
4. Test voltage for 15 kv VCL		
a. Factory - 117 kv		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Acceptance, 80% of factory - 93.6 kv		
c. Proof - 60% for one minute - 70.2 kv		
B. Splicing the Cable	Refer student to text	Student refers to text, page 9-19, fig. 9-21
1. Cutting cables to length		
a. Train cables to desired position; avoid severe bending and allow slight overlap of ends		
b. Cut cables to butt squarely together at desired centerline of splice		
2. Preparation of lead sleeve	Refer to the splice drawing for sleeve size and length	Determine the size and length of sleeve
a. Scrape both ends of the sleeve carefully for 3 or 4 inches and apply sterine flux to cleaned portions	The sleeve on this joint will be split and a solder seam	
b. Slide the sleeve onto one end of the cable		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Removing the lead sheath		
a. Mark the sheath at a distance "A" from each cable end	Following the dimensions in the drawing and in conjunction with the length of the sleeve, mark score and clean the cable sheath. This is distance A on the print	The student can locate the dimension on the print
b. Score the sheath to a depth slightly less than 1/2" of its thickness completely around the cable at this mark		
c. Scrape the sheath clean on each cable for at least 3" beyond this point		
d. Score and apply sterine flux	Apply pasters and tin the prepared area	
e. Slit the sheath up to the score from each end, being careful not to injure the insulation		
f. Tear the lead off in such a manner that a natural bell is formed at the end of the sheath		
4. Preparation of each end for connector		
a. Place a mark on the insulation at a distance of 1/2 the length of connector, plus 1/2" from each end		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. To prevent the insulation from unwinding, tie it with a dry cotton tape just beyond the mark		
c. Cut the insulation squarely down to the conductor at the mark	Caution: Do Not nick the conductor	
d. Protect the ends of the exposed insulation from the heat of soldering by wrapping with a dry cotton tape		
5. Placing and solder the connector		
a. Clean the exposed conductor thoroughly and apply sterine flux		
b. Fit the conductor ends into the connector with the ends butting firmly in center and with the slot or hole in the connector on top		
c. Hold the assembly in this position and squeeze the connector tightly onto the conductors		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Apply heat and solder, making sure that connector and all dents caused by squeezing get filled with solder	Solder the connector, all dents from squeezing the connector must be filled in	
e. Remove excess solder and smooth off all burrs		
6. Preparation of splice for Insulation		
a. Remove the protective covering from ends of insulation		
b. Pencil the insulation on each end for a distance equal to four times the thickness of the insulation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Wipe the entire joint carefully with a clean dry cloth to remove all dirt and loose particles	Thoroughly flush the splice with hot oil	
7. Insulating the splice		
a. Fill the space at each end of connector with 3/16" wide V.C. tape	Use 1/4" Fibermat III polyester web tape and baste with oil if smaller V.C. tape not available	
b. Apply ½" wide, bias cut, V.C. tape over the connector, and at pencils, build up to the level of factory-applied insulation.		
c. Complete the insulating with 1/2", 3/4" or 1" wide bias cut V.C. oil immersed tape applied with 50% lap. Apply the tapes to give a thickness of 2 times that of the factory applied insulation along the middle portion of the splice and tapering down to the factory-applied insulation at the sheath on each end		
8. Installing the sleeve		
a. Center the lead sleeve over the joint and beat the ends		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
of the sleeve down tightly onto the cable sheath		
b. Apply paper pasters to sleeve and cable sheath; (on sleeve 1" from shoulder and on sheath 1" from end of sleeve).		
c. Make a wiped joint between the sleeve and sheath at both ends	NOTE: The holes can be made in the sleeve for filling at this time.	
9. Filling the joint		
a. Fill the sleeve with No. 219 flushing (insulating) oil which is heated to the temperature as shown on the label; this temperature must be checked with a temperometer	NOTE: Tilt the joint slightly and fill through the lower hole.	
b. Level the joint and allow it to stand until it has cooled, and then make a second filling		
c. Clean the holes and the area of the lead around them, apply sterine flux and seal the holes carefully with solder		
10. Securing joint and cable	NOTE: Explain that these steps will be required in the field. This will not be accomplished in the class	
a. Bond cable to other cables and ground		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Apply corrosion or fire protection (if required)		
c. Attach identification tag or mark cable		
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	Student will follow instructions in Job Sheet JS-1.3.7.1
	Hand out splicing tools and materials	
	Supervise and assist as necessary	
	Stress safety factors	
	Test the student's splice	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Cable, 15 kv	Do not introduce new material	
1. Avoid contamination		
2. Voids in insulation		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Insulating tape		
4. Higher test voltage	Have students to hold all questions until completion of summary	
B. Splicing the Cable		
1. Cutting cables to length		
2. Preparation of lead sleeve		
3. Removing the lead sheath		
4. Preparation of each end for connector		
5. Placing and soldering the connector		
6. Preparation of splice for Insulation		
7. Insulating the splice		
8. Installing the sleeve		
9. Filling the joint		Ask questions after completion of summary
10. Securing the joint and cable		
V. Criterion Test:	Hand out splicing tools and materials	Student will demonstrate knowledge by performing a branch splice

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
A. Make a branch splice in accordance with Job Sheet JS-1.3.7.1	Stress safety factors	
	Inform students they will be performing without supervision	
	Grade student on go-no go basis	Position completed splice on test frame
	Have student dismantle his splice and salvage materials after test	

VI. Assignment: None

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.8 STRAIGHT SPLICE, 15 kv, XLP, URD-ALUMINUM

TIME ALLOCATION: Classroom 1 Hour
Practical 15 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
    a. *Underground Systems Reference Book*, 1957 Edition, Edison Electric Institute
    b. *Terminations and Splices - Theory - Practice*, PLM Products, 4799 W 150th St., Cleveland, Ohio
2. Reference:
    a. *UD Technical Manual*, Cyprus Wire and Cable Company
3. Training Aids:
    a. Display Board - Underground Distribution Cable and Completed Splice
    b. Aluminum Cable and Splices - CE "C" 1.3.8.1I
    c. Straight Splice, 15 kv, XLP, URD-Aluminum - CE "C" 1.3.8.1J
4. Training Aids Equipment: None
5. Tools and Equipment:
    a. Cable Splicers Tool Box
    b. Compression tool, Burndy Y34 A
    c. Hacksaw
    d. Sharpening stone
    e. Cable stripper
6. Materials:
    a. Cable, 15 kv, XLP (URD), AWG #1/0, 1/C, 5' per student
    b. Connectors, Mfg. Burndy
        (1) Ys25A, 1/0 (conductor)
        (2) Ys25L, 1/0 (neutral)

c. Tape

   (1) Vinyl, 3/4", 5970 00816 6056 (Scotch 88)

   (2) Semi-conducting, Scotch 13, Bishop 17

   (3) High voltage 3/4" X 30' 5970 00931 4491 (Scotch 23)

d. Abrasive cloth, Grit 320, 5350 00229 3086

e. Cleaning solvent, trichlorethylene

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

   b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours.

   c. XLP shielded cable, three conductor - termination splice - 7.0 hours.

   d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours.

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, and Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.8 Upon completion of this topic the student will be able to construct a straight splice in a 15 kv cross-linked polyethlene insulated, AWG #1/0, with concentric neutral power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice PLM Products, 4799 W 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3.8.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a straight splice in a 15 kv cross-linked polyethlene insulated, AWG #1/0, with concentric neutral power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3.8.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

a. Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 4-39 through 4-46.

b. Read and study Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio, page 13.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise a. How b. When	
II. Presentation:	Make ready the T/A listed for this lesson	
A. Cable, 15 kv, XLP, URD-Aluminum		
1. Train cables into position and overlap them about 6"	Hand out texts, Information Sheet, and Job Sheet for this lesson	Students follow the instructions and note cable size and dimension
2. Bind down concentric-neutral strands - using several turns of vinyl tape - at a point from end of cable that is a distance equal to 6" plus C plus D plus A plus half the length of connector	Explain to students the bind down procedure from diagram	Students participate in obtaining these measurements

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
to be used. For example: 6" + C + D + A + ½ of Conn = (6" + 4½" + 1½" + ½" + 1" = 13½")		
3. Without cutting away any concentric-neutral strands, unwrap them back to the binding of the vinyl tape. Using large pliers, twist strands to form concentric-neutral. Combined with the taped binding, this will keep concentric strands in place when the cable is operational. Bend twisted concentric strands out of the way temporarily	Make this presentation and demonstration with all of the materials and cable preparations prefabricted for expediency	
4. Cut overlapped cables at center of lap, removing about 3" from each cable. Cut carefully so ends butt squarely	Show how these cables must overlap before the cut. This is sometimes forgotten resulting in too short a neutral for connecting	
5. Remove semi-conducting jacket from each cable for a distance equal to C plus D plus A plus half the connector length. Be careful not to cut insulation	Banana peel jacket very carefully (7")	Student can provide this dimension
6. Taper jacket smoothly to approximately 5 times its thickness	Note this dimention	
7. Remove insulation and semi-conducting strand shielding from end of	Ask student for dimension (A plus ½ the connector length - 1½")	Student provides this dimension

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
conductor for distance A plus half the length of connector. Be careful not to nick the conductor.		
8. Taper insulation for distance D, using a penciling tool or sharp knife. If a knife is used, the taper must be buffed to even smoothness with non-conductive abrasive cloth	Before tapering with a knife, exposed conductor should be protected with a few wraps of vinyl tape	Student provides this dimension
9. Join aluminum conductor with suitable compression connector (Burndy YS25A) filled with contact aid	Note: If connector is not filled, contact aid must be applied to conductor before installing connector. Clean off excess contact aid with solvent	
10. Clean exposed cable insulation with clean, lint-free cloth and trichlorethlene, to remove all traces of cable semi-conducting material. Avoid excessive use of solvent		
11. Fill in dents in connector with small pieces of semi-conducting tape. Apply a wrap or two of semi-con tape to conductor at both ends of connector to eliminate sharp edges and fill in shoulders between connector and conductor	Wrap half-lapped layer of semi-con tape smoothly over conductor and connector from bottom of one insulation taper to bottom of the other. Cover any semi-conducting strand shielding that extends beyond insulation tapers; overlap tapered cable insulation with semi-con tape no more than 1/16"	
12. Starting at center of the connector, wrap high-voltage		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
insulating tape, such as "Scotch 23" or equal, in half-lapped layers evenly back and forth over connector and onto insulation of joined cables. Tape should be stretched to manufacturer's recommendations. Continue wrapping evenly back and forth until thickness over connector equals T. Finish each layer slightly short of the preceding one so wrapping will taper evenly at both ends. Tapers should cover all of distance C less 1/8"	Note: Be sure the high-voltage tape does not overlap cable semi-conducting jacket Explain: T = 3/8" C = 4½"	Student provide this dimension
13. Wrap one half-lapped layer of semi-conducting tape over the insulating tape, extending it onto cable semi-conducting jacket for 1"		
14. Clean exposed semi-conducting jacket between semi-conducting tape layer and concentric-neutrals. Use clean lint-free cloth		
15. Cover all of the factory and hand applied semi-con with one half-lapped layer of high-voltage insulating tape		
16. Wrap two half-lapped layers of high grade vinyl tape such as "Scotch 33" over all of the insulating tape.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
Extend it to the concentric-neutral at each end of the splice. Wrap tightly, stretching tape so it conforms well. Apply last several wraps with no tension.		
17. Bring concentric-neutrals together 2" to 4" from cable. Overlap as necessary, then cut carefully so ends butt squarely. Join the two with a suitable copper connector (Burndy YS25L)	Have students observe the guide for proper connector that is provided with the joint diagram. AWG of strand is #14	Students observe guide and provide the size with instructor assistance
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	
1. Make a straight splice in accordance with Job Sheet JS-1.3.8.1	Hand out splicing tools and materials as required for each splice Supervise and assist as necessary Stress safety factors As students complete each splice, test it	Student will follow instructions in Job Sheet listed for this splice

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
IV. Summary:	Review of important subject matter	Give undivided attention
A. Cable, 15 kv, XLP, URD-Aluminum	Do not introduce new material	
	Have students to hold all questions until completion of summary	Ask questions after completion of summary
V. Criterion Test: A. Make a straight splice in accordance with Job Sheet JS-1.3.8.1	Hand out splicing tools and materials as required for this splice	Student will demonstrate knowledge by performing a straight splice
	Stress safety factors	
	Inform students they will be performing without supervision	
	Grade student on go-no go basis as he completes this splice	Position completed splice on test frame
	Have student dismantle his splice and salvage materials after test	
VI. Assignment: a. Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 4-39 through 4-46		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Read and study Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio, page 13.		

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.9 TERMINATION (ALL-TAPE), OUTDOOR W/RAINSHIELD, 15 kv, XLP INSULATED, AWG #2/0, 3/C

TIME ALLOCATION: Classroom 1 Hour
Practical 15 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
    a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. Reference: None
3. Training Aids:
    a. Display Board - Completed XLP 3/C Termination
    b. 15 kv Termination (All-tape), Outdoor with Rainshield - CE "C" 1.3.9.1J
4. Training Aids Equipment: None
5. Tools and Equipment:
    a. Cable Splicers Tool Box
    b. Hacksaw
    c. Sharpening stone
    d. Compression tool, Burndy Indent
6. Materials:
    a. Cable, 15 kv, XLP, AWG #2/0, 3/C, 4' per student
    b. Terminal, Hydent YA26 (Burndy), 3 ea per student
    c. Tapes
        (1) High voltage ozone resistant tape "Scotch" 23
        (2) Copper mesh "Scotch" 24
        (3) Vynal tape "Scotch" 33, GE #8380
        (4) Rubber "putty" - "Scotchfil", FSN 9G5970-00045-3699
        (5) Track resistant tape (special applications)
        (6) Cotton tape

d. Copper wire, AWG #20

e. Rubber cement "Scotchkote"

f. Wire solder

g. Rainshields, PLM Cat. No. RHS, f/3/4" insulation diameter

h. Trichlorethane

i. Wiping rags

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

    a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

    b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours.

    c. XLP shielded cable three conductor - termination splice - 7.0 hours.

    d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours.

These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.9 Upon completion of this topic, the student will be able to construct a termination splice in 15 kv, cross-linked polyethylene (XLP), AWG #2/0, 3 conductor power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet 1.3.9.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a termination splice in 15 kv, cross-linked polyethylene (XLP), AWG #2/0, 3 conductor power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet 1.3.9.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes inaaccordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK - None

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Relate the value of the subject matter to the student State topic objectives Explain the method(s) to be used Topic Criterion Exercise a. How b. When	Students bring out individual needs for this lesson
II. Presentation:		
A. Cable	Make ready the T/A listed for this lesson	
1. Cross-linked polyethlene insulation (Amerlink-X)	Hand out text and job sheet for this lesson	
2. Polyvinylchloride jacket		
3. AWG #2/0, 3 conductor	Relate this lesson to the 5 kv "K" tape, 1/C, termination. Note that with solid dielectric type cables the tape termination is far more practical than a pothead	
B. Splicing the Cable		
1. Cut cable to length		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Train the cable to desired final position (without sharp bends) and mark the jacket where cable is to be cut, making sure to leave enough length so that outer conductors can be fanned out into their proper positions.	State what the dimensions are to be along with class participation in making the measurements of the terminal lug	Measure the lug to determine how much of the conductor should be exposed
b. Cut the cable squarely at the mark		
2. Remove cable jacket	Again the instructor brings out only new and/or important points as several of the steps are repetitious of other joints completed	
a. Remove the cable jacket and underlying tape, if any, for the distance A.		
b. Bind the conductors and ground wires firmly together at the end of the jacket with cotton tape or other suitable material to prevent injury to the jacket while the lugs, stress cones, and rain shields are being applied		
c. Loop ground wires back out of the way and temporarily tie them, if necessary, but do not cut		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Spread the conductors apart to assimilate their final terminated positions and make any necessary adjustments to the length of the middle conductor		
3. Prepare each conductor for lug		
a. Strip the conductor for a distance equal to the depth of hole in lug, plus 1/2" for cable sizes 4/0 AWG and smaller, and plus 1" for cables larger than 4/0 AWG		
b. Cover the end of insulation and shield with a wrapping of dry cotton tape for protection against the heat of soldering	Inform students that this step is not necessary if an indent type (compression) connector is used. The use of "Burndy" and T&B compression tools have been covered in the first phases of the course	
4. Attach lug to each conductor		
a. Apply sterine flux to conductor and solder it carefully, making sure that conductor strands within the lug are filled with solder		
c. Remove the protective covering from end of insulation	Polish the lug - state that drips, bumps or points of solder will lead to a concentration of stress at that point	

5. Prepare for building stress cones

   a. Remove the shield and underlying tape or tapes to within the distance B of cable jacket

   b. Pencil the insulation for a distance equal to 4 times the thickness of the insulation

   c. Clean and roughen the penciled portion and exposed insulation with a coarse file or non-conducting abrasive cloth

   d. Wash the roughened surfaces, the exposed strand and the lug with a cleaning agent (Tri-chlorethlene). Make sure that no conducting particles remain on the insulation

6. Build stress cones

   a. Apply rubber cement to portion of insulation where stress cone is to be built. Allow cement to dry until tacky.

      Refer students to table on job sheet for dimentions

   b. Apply ozone resistant insulating tape with approximately 50% overlap. Build to a thickness at the midpoint of 1½ times that of factory applied insulation and taper down to cable insulation on job sheet diagram

c. Cover 1/2" of the exposed factory shield and the cone to its midpoint with 5/8" wide copper-mesh tape applied with a 50% overlap

d. Bind the copper-mesh tape, at the midpoint of the cone, with fine copper wire

e. Solder the copper-mesh tape to the factory applied shield, being careful not to burn the insulation

7. Cover stress cones

a. Completely cover the stress cone, plus 2" on each end, with 4 layers of "Scotch" 33 (or similar) tape, consisting of two tapes each applied spirally with a 50% overlap

8. Install rain shield

a. At a point equal to the length of the rain shield from upper

(

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
edge of stress cone build a ring or shoulder with friction tape to support the rain shield		
b. Slide the rain shield over the lug and into position against the shoulder		
9. Seal rain shield and conductor ends		
a. Apply rubber cement to the top 1½" of rain shield, 1½" of adjacent insulation, the cylindrical portion of the lug, the exposed conductor and 1½ of insulation at penciled end. Allow the cement to dry until tacky.		
b. Apply ozone resistant insulating tape over the cemented surfaces. Apply tape with a 50% overlap and of sufficient thickness to form a watertight seal		
c. Completely cover the hand-applied insulating tape forming the seals at the lug and rain shield, plus the exposed factory applied insulation, with 4 layers of "Scotch" 33 tape consisting of two tapes, each applied spirally with a 50% overlap.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
NOTE: When rain shield is omitted on an indoor installation, seal end of cable only before completing part C.		
10. Build watertight seal for cable end		
a. Train all the conductors, the ground wires to their final position and secure them	Explain that a clearance between lugs at final position should be a minimum of 1" per kv of cable rating	
b. Block the cable carefully with "Scotchfil" to form a watertight seal at the end of cable jacket. The blocking should be done before and after the repositioning of the ground wires		
c. Pencil the end of the cable jacket		
d. Wash the pencilled end and the adjacent 3" of cable jacket with trichlorethane		
e. Apply rubber cement to the dressed portions of the cable jacket, the "Scotchfil" blocking and the exposed conductor shield and allow to dry until tacky		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
f. Wrap ozone-resistant insulating tape over the cemented sections to form a watertight seal		
g. Completely cover the hand-applied insulating tape with 4 layers of "Scotch" 33, or equal, consisting of 2 tapes each applied spirally with a one-half lap		
11. Special conditions		
a. Anhydrous tape may be used in place of the vynal tape and, when used, it should be painted with P&B paint (or GE Glyptal)		
b. In addition to step 10 above, it is further recommended, for severe corrosive atmospheres or moist salt air conditions, the completed terminations (with all lugs bolted to terminals) be sprayed with a protective coating material such as "Krylon"	Inform the students that "Scotch" 70 silicone rubber electrical tape can be used for these conditions. A stock item FSN 9G 5970 00840 8454 ($4.10)	
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Practical Application Period	Inform students this segment will be taught in the shop area	Student will follow instructions in Job Sheet JS-1.3.9.1
1. Make a termination splice in accordance with Job Sheet JS-1.3.9.1	Hand out splicing tools and materials	
	Supervise and assist as necessary	
	Stress safety factors	
	Test the student's splice	
IV. Summary:	Review of important subject matter	Give undivided attention
A. Cable		
1. Cross-linked polyethlene insulation (Amerlink-X)	Do not introduce new material	
2. Polyvinylchloride jacket		
3. AWG #2/0, 3 conductor	Have students to hold all questions until completion of summary	
B. Splicing the Cable		
1. Cut cable to length		
2. Remove cable jacket		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Prepare each conductor for lug		
4. Attach lug to each conductor		
5. Prepare for building stress cones		
6. Build stress cones		
7. Cover stress cones		
8. Install rain shield		
9. Seal rain shield and conductor ends		
10. Build watertight seal for cable end		
11. Special conditions		Ask questions after completion of summary
V. Criterion Test:	Hand out splicing tools and materials	Student will demonstrate knowledge by performing a termination splice
A. Make a termination splice in accordance with Job Sheet JS-1.3.9.1	Stress safety factors	
	Inform students they will be performing without supervision	
	Grade student on go-no go basis	Position completed splice on test frame
	Have student dismantle his splice and salvage materials after test	

VI. Assignment: None

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.10 TRIFURCATION/ TRANSITION 1 WAY-3 WAY, 15 kv, THREE 1/C CROSS-LINKED POLYETHLENE SHIELDED TO A PAPER INSULATED-LEAD SHEATHED 3/C POWER CABLE

TIME ALLOCATION: Classroom 2 Hours
Practical 35 Hours

INSTRUCTIONAL MATERIALS:

1. Test:
   a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. Reference: None
3. Training Aids:
   a. Drawing (Large Reproduction) - 3M2047P-5 One Way-Three Way Joint, Three Conductor Paper to Three Single Conductor Polyethylene Cables, 3M Company, Electro Products Division.
   b. Slides - 35 mm (locally produced) - Sequence of 1 Way-3 Way Joint.
   c. Display board - Trifurcation/Transition 1 Way-3 Way Splice.
   d. One Way-Three Way Joint, Three Conductor PILC to Three Single Conductor XLP Power Cable - CE "C" 1.3.10.1J.
4. Training Aids Equipment:
   a. Projector, 35 mm
5. Tools and Equipment:
   a. Cable splicer's tool box
   b. Hacksaw/cable splicers saw
   c. Sharpening stone
   d. Resin pressure gun
6. Materials:
   a. Cable
      (1) 15 kv, 1/C, XLP
      (2) 15 kv, 3/C, PILC
   b. Connector, split tinned

c. Tapes

   (1) Varnished-cambric (dry) 3/4"

   (2) Fibermat, II or III, 1/2" & 1/4"

   (3) Shielding Tape, Scotch 24

   (4) Spacer Tape P-3, "Scotchcast"

   (5) Vinyl Tape, #88, 1-1/2"

   (6) Restricting Tape P-4

d. Glyptal lacquer, GE 1201

e. P-1 Injection Fitting

f. P-5 Nozzle

g. "Scotchcast" Resin #4, size C

h. "Scotchfil" Electrical Putty

i. Irvington Oil Stop No. 621

j. Cable Preparation Materials

   (1) Abrasive cloth, grit-80

   (2) Abrasive cloth, grit-320

   (3) Lint free cloth

   (4) Solvent (Trichlolethlene)

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit, the student will be able to:

1. Splice single and three conductor, 15 kv power cable in the below listed types of cable. The type of splice to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. Varnished cambric insulation-lead sheathed cable, single conductor - branch splice - 14.0 hours.

   b. XLP shielded (URD) cable, single conductor - straight splice - 7.0 hours.

   c. XLP shielded cable, three conductor - termination splice - 7.0 hours.

   d. XLP shielded or unshielded to paper insulated-lead covered (PILC) cable, three conductor - straight transition splice - 21.0 hours.

   These splices will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3J series without deviation All splices will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.10 Upon completion of this topic, the student will be able to construct a straight trifurcation/transition splice with three 15 kv, single conductor, cross-linked polyethlene power cables to a 15 kv, three conductor, paper insulated-lead covered (PILC) power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.10.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST:

The student will construct a straight trifurcation/transition splice with three 15 kv, single conductor, cross-linked polyethlene power cables to a 15 kv, three conductor, paper insulated-lead covered (PILC) power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.10.1J without deviation. The splice will be required to withstand an acceptance test of 52.8 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK

1. Read and study Underground Systems References Book, 1957 Edition, Edison Electric Institute, pages 9-13 through 9-22.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired lines	
C. Establish Effect	Show the student the value of the subject matter to him	
D. Overview	State topic objectives	
	Explain the method(s) to be used	
	Topic Criterion Exercise How? When?	
II. Presentation:	Make ready the T/A's listed for this lesson	
A. Construction of a 15 kv Trifurcation/ Transition, 3/C (PILC) to Three 1/C XLP Cables	Hand out text and Job Sheet for this lesson	
1. Cable preparation	Show 35 mm slides	
a. Train cables to their final position and cut to proper length. Be sure cable ends butt squarely.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Thoroughly clean cable ends		
(1) Ring and tin (PILC) ends at "A" dimensions.		
c. Split sheath of PILC cable with chipping knife up to the circumferential cut. Take care not to cut cable insulation with chipping knife.		
d. Tear split sections of sheath loose by pulling on one end directly away from cable. Remove copper binder tape for all but 3/4" from end of lead sheath. Be careful not to cut into cable shielding.	Slide #3 shows cable sheath removed.	
e. Remove cable metallic shields as per print dimension and solder together with binder tape as per instructions.		
f. Remove cable insulation 1/2 the connector length plus 1/2". When using solder type connector, clean conductor strands and apply sterine flux.	This refers to the PILC conductors; the student can make note on his joint diagram	Student measures the length of connector and verifies this dimension on his print.
g. Remove the jacket and separater tape from the XLP cables. Do not cut through the shielding		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
tape or wires. Dimension "A" plus 1/2 the connector length.		
h. Remove metallic shielding tape or wires for all but 1" taking care not to cut into the insulation. Remove semi-conducting insulation shielding to 1/4" from the end of the shielding tape or wires.	Again, have the students recall that if a cable has concentric shield wires these will be prepared as per instructions in 3M print "Wire Shield Procedure"	Ensure student comprehension
i. Remove cable insulation from the three XLP conductors 1/2 the connector length plus 1/2". This should be done with a "PLM" stripper.		
2. Preparation for connectors.		
a. Install split-tinned connectors, tighten with eagle-beak pliers and solder sweat. Polish connector thoroughly removing all projections.	Note No. C1 & 2 on drawing. Protect insulation with cotton tape while sweating	
b. Pencil the insulations of both cables 3/4". Use sharp knives and abrasive cloth to insure a smooth taper.	Remember to wrap the end of the paper insulation with dry V.C. tape to prevent the insulation from unwrapping.	

UTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Preparation for lead sleeves.		
a. Insulating the splice (Joint).		
(1) Build an oil stop on the three XLP conductors by putting (8) one-half lapped layers of varnished silk tape with a coating of lacquer, enamel or oil stop compound between each layer. The oil stop is to go from the auxiliary sleeve to the middle of the connector.	Dry V.C. or polyester glass tape may be used. Allow the compound to dry before each layer of tape.	
(2) Fill the space between connector and lead covered cable insulation with 1/4" wide varnished cambric tape or fibermat III.		
(3) Tape over the connector and pencil with 1/2" V.C. tape up to the level of the factory applied insulation.		
(4) Build up splice with 3/4" V.C. tape.		
(5) Apply one-half lapped layer of copper mesh tape over the 3/4" V.C. tape.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Boil out paper side up to connector only, not beyond. Thoroughly clean the XLP side. Keep each leg as straight as possible prior to and during the application of the tape.	Project slides #4 & 5.	
c. Attach banding wires.		
4. Make a "Scotchfil" seal 3 inches from the end of the cable jackets.	Note details on 3M print.	
5. Clean the lead sheath again. Apply two half lapped layers of rubber tape for 3 inches along the sheath starting 1 inch from the end.		
6. Apply resin overcast sheath.		
7. Mix and inject resin through the P-1 injection fitting.		
8. After the splice has cooled and set, prepare the cable for testing.		
III. Application:		
A. Questions - (Oral questions prepared by the instructor).	Conduct oral quiz	Participate in quiz by answering questions.
B. Practical Application Period	Inform students this segment will be taught in the shop area.	Student will follow instructions in Job Sheet CE "C" 1.3.10.1.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Make a straight trifurcation/transition splice with three 15 kv, single conductor, cross-linked polyethlene power cables to a 15 kv, three conductor, paper insulated-lead covered (PILC) power cable in accordance with Job Sheet CE "C" 1.3.10.1J.	Hand out splicing tools and materials. Supervise and assist as necessary. Stress safety factors. Test the student's splice. Review of important subject matter.	
IV. Summary:	Review of important subject matter.	
A. Construction of a 15 kv Trifurcation/Transition, 3/C (PILC) to Three 1/C XLP Cables.	Do not introduce new material.	
1. Cable preparation	Have students to hold all questions until completion of summary.	
2. Preparation for connectors		
3. Preparation for lead sleeves		
4. Make a "Scotchfil" seal 3 inches from the end of the cable jackets.		
5. Clean the lead sheath again.		
6. Apply resin overcast sheath.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
7. Mix and inject resin		
8. After the splice has cooled and set prepare for testing.		Ask questions after completion of summary.
V. Test:	Hand Out splicing tools and materials.	Student will demonstrate knowledge by making a straight trifurcation/transition splice.
A. Make a straight trifurcation/transition splice with three 15 kv, single conductor, cross-linked polyethlene power cables to a 15 kv, three conductor, paper insulated-lead covered (PILC) power cable in accordance with Job Sheet CE "C" 1.3.10.1J.	Stress safety factors.	
	Inform students they will be performing without instructor assistance	
	Grade student on Go/No Go basis as he completes the splice	Position completed splice on test frame.
	Have student dismantle his splice and salvage materials after test.	
VI. Assignment:		
A. Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 9-13 through 9-22.	Ask oral questions on reading assignment	Participate by answering oral questions.

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.11 PULLING-EYE ATTACHMENT ON A 5 kv RUBBER-LEAD, 1/C POWER CABLE

TIME ALLOCATION: Classroom 1 Hour
Practical 4 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
   a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. Reference:
   a. The Rome Cable Manual of Technical Information, 2nd Edition 1957, Rome Cable Corporation, Rome, N.Y. (Now, Cyprus Wire and Cable Company)
3. Training Aids:
   a. Display Board - Depicts various steps of Pulling-eye Construction
   b. Pulling-eye Attachment - CE "C" 1.3.11.1J
4. Training Aids Equipment: None
5. Tools and Equipment:
   a. Cable Splicers Tool Box
   b. Hacksaw
6. Materials:
   a. Cable, 5 kv, Rubber-Lead, AWG #4/0, 1/C
   b. Pulling eye bolt
   c. Paper pasters
   d. Tinned copper wire, AWG #14
   e. Solder 40/60 (wiping)

TERMINAL OBJECTIVE

Supported entirely by this lesson topic:

#1.3 Upon completion of this unit the student will be able to:

1. Splice special joints in single conductor, 5 kv and 15 kv power cable in the below listed types of cable. The type of special joint to be made in each cable and the time limit prescribed are as indicated by each cable.

a. 5 kv, rubber insulation-lead sheathed cable, single conductor - pulling eye joint - 2.0 hours.

b. 15 kv, varnished cambric cable, single conductor - live end cap - 6.0 hours.

These splices and special joints will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices and special joints, with the exception of the pulling eye, will be required to withstand an acceptance test in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

The pulling eye joint will be required to withstand a pulling force of 6000 pounds on a single conductor cable or 5000 pounds on a three conductor cable in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.11 Upon completion of this topic the student will be able to construct a pulling eye attachment on a 5 kv rubber insulated-lead sheathed, single conductor power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.11.1J without deviation. The pulling eye joint will be required to withstand a pulling force of 6000 pounds in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

CRITERION TEST

The student will construct a pulling eye attachment on a 5 kv rubber insulated-lead sheathed, single conductor power cable utilizing the appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.11.1J without deviation. The pulling eye joint will be required to withstand a pulling force of 6000 pounds in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

HOMEWORK

Read and study Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 8-4, 8-5 and 8-15, 8-16.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective	
	Explain the method(s) to be used	
	Topic Criterion Exercise a. How b. When	
II. Presentation:	Make ready the T/A listed for this lesson	
A. Pulling Tensions	Hand out text, and Job Sheets for this lesson	
1. American Institute of Electrical Engineers - recommendations		
a. Maximum pulling tension on cable		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) The maximum strain on a conductor with a pulling eye should not exceed 0.008 times cir-mil area	Place the values for this cable on the C/B	
Tm = .008 X n X CM Tm = max. tension in lbs. n = number of conductors CM = cir-mil area of each conductor	Tm = 1692.672 n = 19 CM = 11136	Student uses these figures and finds maximum tension
(2) Use of cable grip over lead sheath, maximum strain should not exceed 1500 lbs./sq. inch (cross-sectional area	Place the values required for use of cable grip only	
Tm = 4712t (D - t) t = sheath thickness, inches D = overall diameter of cable, in inches	Tm = 346.219 t = .078 D = 1.02	Student uses these figures and finds maximum tension
(3) With the type of pulling eye attachment to be constructed where the sheath and the conductor will be securely joined, the two tensions may be added together for this small cable	Total these on the C/B for max. tension of this cable and sheath Cable conductor - 1692.672 Cable sheath - +346.219 Max. tension - 2038.891	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Construction of Pulling Eye	To expedite the presentation fabricate the various steps in advance. These can be placed on a display board and the instructor can point out the construction step by step	The student can follow the lesson on the diagram in job sheet
1. Cut end of cable square		
2. Mark lead sheath at 3½ inches from cable end (reference Mark)		
3. Cut back to the mark with four "V" shaped cuts. Larger cables may require more.		
4. Bend lead sheath back over cable and remove all insulation		
5. Bend the two outer layers of strands back over sheath and cut the remaining inner strands 1 1/8 inches from reference mark		
6. Place head of bolt as shown in drawing	NOTE: If strands of outside layer do not fit evenly around shank of bolt remove three evenly spaced strands from the outer layer before making the solder "sweat".	
7. Then bend the outer strands over head of bolt to fit evenly on shank of bolt		
8. Bind strands with six turns of #14 AWG copper wire and sweat thoroughly	NOTE: Protect threads from solder by covering with paper pasters ½" beyond reference point after beating of sheath.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
9. Beat ends of sheath forward over solder "sweat"	CAUTION: Outside diameter of wipe must not exceed outside diameter of cable. Exercise care in making the wipe waterproof to insure against the entrance of moisture into the cable when pulling through the ducts.	
10. From a point ½" beyond reference mark make a waterproof wipe over "sweat"		
III. Application:		
A. Practical Application Period		
1. Make a pulling eye joint in accordance with Job Sheet CE "C" JS-1.3.11.1	Inform students this segment will be taught in the shop area Hand out splicing tools and materials as required for this joint Supervise and assist as necessary Stress safety factors Test the pulling eye joint as students complete it	Student will follow instructions in Job Sheet listed for this lesson
IV. Summary:	Review of important subject matter	Give undivided attention
A. Pulling Tensions	Do not introduce new material Have students to hold all questions until completion of summary.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Construction of Pulling Eye		
1. Cut end of cable square		
2. Make reference mark		
3. Make the "V" cuts		
4. Bend cable back and remove insulation		
5. Bend and cut strands for placement of bolt		
6. Bend the outer strands over bolt and wire them down with the binding wire		
7. "Sweat" solder the binding and wire strands		
8. Beat the ends of sheath over and "sweat"		
9. Make a waterproof wipe over the sweated end		Ask questions after completion of summary
V. Criterion Test:	Hand out splicing tools and materials as required for this joint	Student will demonstrate knowledge by performing a pulling eye joint
A. Make a pulling eye joint in accordance with Job Sheet CE "C" JS-1.3.11.1		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
	Stress safety factors	
	Inform students they will be performing without supervision	
	Grade student on go-no go basis as he completes this joint	Position completed joint on test frame
	Have student dismantle his joint and salvage materials after test	
VI. Assignment:	Ask oral questions on reading assignment	Participate by answering oral questions
A. Read and study pages 8-4, 8-5 and 8-15, 8-16 in Underground Systems Reference Book, 1957 Edition, Edison Electric Institute		

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIANS/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.3.12 LIVE END CAP ON A 15 kv, 1/C, VARNISHED-CAMBRIC INSULATED-LEAD COVERED POWER CABLE

TIME ALLOCATION: Classroom 1 Hour
Practical 10 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
    a. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute
2. Reference: None
3. Training Aids:
    a. Display Board - Phases of Construction of a "Live End Cap"
    b. Live End Cap for 15 kv Varnished-Cambric Insulated-Lead Covered Power Cable - CE "C" 1.3.12.1J
4. Training Aids Equipment: None
5. Tools and Equipment:
    a. Cable Splicers Tool Box
    b. Hacksaw/cable splicers saw
    c. Sharpening stone
    d. Soldering coppers
6. Materials:
    a. Cable, 15 kv, V.C.L., AWG #4/0, 1/C, 7' per student
    b. Molded Test Cap, Size No. 1
    c. Lead sleeving, 2½" X 18"
    d. Varnished-cambric cloth tape
    e. Tinned-copper mesh tape
    f. Taping compound
    g. Paper pasters

TERMINAL OBJECTIVE

SUPPORTED ENTIRELY BY THIS LESSON TOPIC:

#1.3 Upon completion of this unit the student will be able to:

1. Splice special joints in single conductor, 5 kv and 15 kv power cable in the below listed types of cable. The type of special joint to be made in each cable and the time limit prescribed are as indicated by each cable.

   a. 5 kv, rubber insulation-lead sheathed cable, single conductor - pulling eye joint - 2.0 hours.

   b. 15 kv, varnished cambric cable, single conductor - live end cap - 6.0 hours.

These splices and special joints will be constructed in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th St., Cleveland, Ohio, and Job Sheet CE "C" 1.3J series without deviation. All splices and special joints, with the exception of the pulling eye, will be required to withstand an acceptance test inaccordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

The pulling eye joint will be required to withstand a pulling force of 6000 pounds on a single conductor cable or 5000 pounds on a three conductor cable in accordance with American Institute Electrical Engineers Insulated Conductor Committee standards to satisfactorily complete this objective.

ENABLING OBJECTIVE

Supported entirely by this lesson topic:

#1.3.12 Upon completion of this topic the student will be able to construct a live end cap on a 15 kv, single conductor varnished-cambric insulated-lead covered power cable utilizing appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.12.1J without deviation. The live end cap will be required to withstand an acceptance test of 93.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

CRITERION TEST

The student will construct a live end cap on a 15 kv, single conductor varnished-cambric insulated-lead covered power cable utilizing appropriate tools and materials in accordance with Underground Systems Reference Book, 1957 Edition, Edison Electric Institute and Job Sheet CE "C" 1.3.12.1J without deviation. The live end cap will be required to withstand an acceptance test of 93.6 kv for 15 minutes in accordance with Insulated Power Cable Engineers Association (IPCE) standards when tested with a DC High Potential Tester to satisfactorily complete this objective.

HOMEWORK: None

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	Students bring out individual needs for this lesson
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise a. How b. When	
II. Presentation:	Make ready the T/A listed for this lesson	
A. Application of a 15 kv Live End Cap	Hand out texts and Job Sheet for this lesson	
1. Cable preparation		
a. Cut cable end square using one of the following		
(1) Cablemans saw		
(2) Hacksaw		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
b. Measure and mark the sheath at 6½" for this 15 kv, VCL cable	Have the students note this dimension on the Live End Cap Print	Students verify the 6½" dimension
c. Ring the cable sheath with ringing tool or chipping knife	This step to be shown the students if it is not repetitious	
d. Using a shave hook, clean lead sheath 3 to 4 inches back from the cable ring		
e. Apply sterine to cleaned portion		
f. Apply pasters (1) One paster to cover ring and ½ inch of the cleaned portion of sheath (2) One paster at other end of the cleaned area		
g. Tin the cleaned portion of the sheath		
h. Remove paper pasters		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i. Remove lead sheath using - (1) Chipping knife (2) Tinners hammer	When slitting and removing the sheath use a twisting motion that will leave a natural bell at end of the sheath	
j. Remove shielding or semi-conducting tapes back to ¼" of sheath		
k. Remove one layer of varnished-cambric insulation after the semi-conducting tape is removed		
2. Cap preparation		
a. Check drawing for correct size of end cap to be used for this cable	Point out to the student that there are only two sizes. With varnished-cambric or paper insulated cables, size No. (1) is used for conductors up to and including 500 MCM	Student makes note on his/her diagram
b. Remove or build up conductor insulation with 3/4 inch dry or oil-varnished-cambric tape when required to snugly fit molded test cap (1) Apply taping compound on end of conductor and between layers	NOTE: Slightly turning test cap in the direction of tape lay may prevent the tape from unraveling	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(2) Coat the inside of the test cap with oil and slide over the end of conductor		
3. Final preparation of live end cap		
a. Start taping with oil immersed V.C. tape ¼" from the end of sheath or tape shielding. Taper this up over the test cap. For 15 kv cover the mold to a dimension of 3/16"		
b. Apply shielding stress cone	Show a completed end cap with a copper mesh stress cone	
(1) Start from ½" on cleaned portion of lead sheath		
(2) Build up shielding at natural bell of sheath to form a smooth taper		
(3) One layer half-lapped to distance required on drawing or high point of insulation taper		
(4) Spot solder copper mesh	Do not use excess solder, point out the areas to be soldered	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Apply lead end sleeve as required by drawing for this conductor size	With students and the prints determine the dimension	Students provide the dimension
(1) Clean sleeve 3 to 4 inches and apply sterine to the cleaned area		
(2) Slide sleeve over end cap and cable	CAUTION: Do not damage insulation	
(3) Beat down end of sleeve evenly to fit snug to the cable sheath	Explain that this is a good time to provide hole for filling with taping compound	
(4) Apply paper pasters		
(a) At ridge of sleeve where beat down began		
(b) At correct distance away from sleeve on cable sheath		
(5) Wipe lead sleeve with wiping solder	Observe all safety precautions when handling molten solder	
(6) Remove pasters		
d. Fill the sleeve with taping compound		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
(1) Let compound cool - then check and refill with compound as required		
(2) Seal the holes with plugs or wipe with bar solder		
e. Apply arc and fire proofing tape as required	Point out a previously taped sleeve that will show how the glass tape is applied	
(1) Tape ends of arc proof tape with glass tape		
f. Support and tag cable end	Display a completed "simulated" live end cap	
(1) Support end of cable according to installation being used		
(2) Tag the cable stating the following information:		
(a) Cable number (feeder #)		
(b) Phase if single conductor		
(c) Voltage rating		
(d) "LIVE END CAP"		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application:		
A. Questions - (Oral questions prepared by the instructor)	Conduct oral quiz	Participate in quiz by answering questions
B. Practical Application Period	Inform students this segment will be taught in the shop area	Student will follow instructions in Job Sheet listed for this lesson
1. Apply a live end cap on a 15 kv 1/C, varnished-cambric cable in accordance with Job Sheet CE "C" JS-1.3.12.1	Hand out splicing tools and materials as required for this lesson	
	Supervise and assist as necessary	
	Stress safety factors	
	As students complete the live end cap, test it	
IV. Summary	Review of important subject matter	Give undivided attention
A. Application of a 15 KV Live End Cap	Do not introduce new material	
1. Cable preparation	Have students to hold all questions until completion	Ask questions after completion of summary
2. Cap preparation		
3. Final preparation of live end cap		

OUTLINE OF INSTRUCTION	INSTURCTOR ACTIVITY	STUDENT ACTIVITY
V. Criterion Test:	Hand out splicing tools and materials as required for this lesson	Student will demonstrate knowledge by performing a live end cap joint
A. Apply a live end cap on a 15 kv 1/C, varnished-cambric cable in accordance with Job Sheet CE "C" JS-1.3.12.1	Stress safety factors	
	Inform students they will be performing without supervision	
	Grade student on go-no go basis as he completes this live end cap application	Position completed live end cap on test frame
	Have student dismantle his live end cap and salvage materials after test	
VI. Assignment:		
A. Note reference pages in Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 9-24 and 9-47		

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIAN/ CABLE SPLICING A-721-0023

CLASSIFICATION: Unclassified

TOPIC NUMBER AND TITLE: 1.4.1 PLANNING AND ESTIMATING (TELEPHONE CABLE)

TIME ALLOCATION: Classroom 7 Hours
Practical 0 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
    a. Seabee Planner's and Estimator's Handbook, NAVFAC P-405
2. Reference: None
3. Forms (Locally prepared)
    a. Material Estimate Work Sheet
    b. Labor Estimate Work Sheet
    c. Material Estimate Recap Sheet
4. Drawing:
    a. Telephone Cable
5. Training Aids:
    a. Tools, Materials, and Equipment CE "C" 1.4.1.1I
6. Training Aids Equipment: None
7. Tools and Equipment: None
8. Material: None

TERMINAL OBJECTIVE

Supported partially by this lesson topic:

#1.4 Upon completion of this unit the student will be able to plan and estimate for mandays and materials to make telephone cable and power cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook. The mandays for each splice will be estimated in accordance with NAVFAC P-405, Seabee Planner's and Estimator's Handbook and materials estimate will be within + 5% of an instructor prepared Material Take Off (MTO) for each splice.

ENABLING OBJECTIVE

Supported partially by this lesson topic:

#1.4.1 Upon completion of this topic the student will be able to plan and estimate for mandays and materials to make telephone cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook. The mandays for each splice will be estimated in accordance with NAVFAC P-405, Seabee Planner's and Estimator's Handbook without deviation. The estimate for materials of each splice will be taken from the appropriate job sheet setting up the procedure for its construction and must be within ± 5% of an instructor prepared Material Take Off (MTO) on that splice.

CRITERION TEST

Upon completion of this topic the student will plan and estimate for mandays and materials to make telephone cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook. The mandays for each splice will be estimated in accordance with NAVFAC P-405, Seabee Planner's and Estimator's Handbook without deviation. The estimate for materials of each splice will be taken from the appropriate job sheet setting up the procedure for its construction and must be within ± 5% of an instructor prepared Material Take Off (MTO) on that splice.

HOMEWORK

Read and study pages 1-1 thru 2-10 and 4-1 thru 4-8 in Seabee Planner's and Estimator's Handbook, NAVFAC P-405

Note: Tables 4-136, 137, 140.

455

456

330

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line	
C. Establish Effect	Show the student the value of the subject matter to him	
D. Overview	State topic objective Explain the method(s) to be used Topic Criterion Exercise: How? When?	
II. Presentation		
A. Make Estimates of Material For a Project	Hand out text, forms, diagram, specifications, and appropriate job sheet to students.	
1. Material estimates		
a. Used as a basis for material procurement and also as a check to see if material is available.		
(1) Sometimes referred to as a Bill of Materials or a Material Take Off		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY

(2) An error can cause serious delays in a project

b. Obtain work element quantity

(1) Using information on work element estimate work sheets start filling out material estimate work sheet

(2) List the splices to be made by size and type

(3) Convert work element quantities into materials required to do the job

(a) Directly under each work element description show the materials required by type and kind

(b) In the work element quantity column, show the work element quantity

(c) In the conversion unit column show the conversion unit. Example - (2 ft. lead sleeve/ea splice.)

(d) In the quantity required column show result of work element quantity times the conversion unit.

(e) In required column show special requirements

Note: If estimates are made directly from prints, use colored pencils to mark over areas of print covered to avoid omissions.

c. After computing on work sheets, enter on recap sheets with like material grouped together and totaled.

(1) In description columns, list type of material and breakdown of where used.

(2) In quantity column list quantity for each area.

(3) Total quantity column for each type of material.

(4) In waste and loss factor column show allowance, usually 10%.

(5) In waste and loss column show results of multiplying waste and loss factor times total quantity.

Note: Where possible use check lists and tables for estimating materials needed and waste and loss factors.

(6) In quantity to procure column enter sum of quantity plus waste and loss.

(7) In remarks column, list any special order details.

d. Heading on material recap worksheets.

(1) Sheet number and number of sheets.

(2) Name of estimator and date.

(3) Name of estimate checker and date.

(4) Unit

(5) Location

(6) Year

(7) Project number

(8) Description of project

B. Make Estimates of Mandays Required For Project.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
1. Preparing Estimate		
a. Obtain work element quantity from work element estimate.		
b. Select from appropriate table, the mandays per unit figure.		
c. Multiply mandays per unit figure by the quantity to obtain mandays required for work unit.		
d. Work element summary sheet can be used by adding two columns marked "Mandays Per Unit" and "Mandays Required".		
e. Work sheets may be made up to meet needs.		
2. Production Efficiency		
a. Guide Chart		
(1) Production elements		
(2) Areas of evaluation		
b. Graft		
(1) Working minutes per hour		
(2) Delay		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application:		
A. Practical Application Period		
1. Make manday estimate for appropriate splice	Supervise and assist as necessary	
2. Make a material estimate using appropriate job sheet for splice indicated by instructor		
IV. Summary:	Review of important subject matter	Give undivided attention
A. Make Estimates of Material For a Project	Do not introduce new material	
1. Material estimates	Have students to hold all questions until completion of summary	
B. Make Estimates of Mandays Required for Project		
1. Preparing estimate		
2. Production efficiency		Ask questions after completion of summary.
V. Test:	Insure that each student has the appropriate forms, specifications, and job sheets.	Student will demonstrate his knowledge by performing manday and material estimates on appropriate splice as indicated by instructor.
A. Make manday estimate for appropriate splice		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Make a material estimate using appropriate job sheet for splice indicated by instructor.		
	Grade students on a go, no go basis	
VI. Assignment:		
A. Read and study Pages 1-1 thru 2-10 and 4-1 thru 4-8 in Seabee Planner's and Estimator's Handbook, NAVFAC [illegible]405.	Ask oral questions on reading assignment	Participate by answering oral questions.

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

COURSE TITLE AND NUMBER: CONSTRUCTION ELECTRICIAN/
A-721-0023

TOPIC NUMBER AND TITLE: 1.4.2 PLANNING AND ESTIMATING (POWER CABLE)

TIME ALLOCATION: Classroom 7 Hours
Practical 0 Hours

INSTRUCTIONAL MATERIALS:

1. Text:
    a. Seabee Planner's and Estimator's Handbook, NAVFAC P-405
2. Reference: None
3. Forms: (Locally prepared)
    a. Material Estimate Work Sheet
    b. Labor Estimate Work Sheet
    c. Material Estimate Recap Sheet
4. Drawing:
    a. Power Cable
5. Training Aids: None
6. Training Aids Equipment: None
7. Tools and Equipment: None

TERMINAL OBJECTIVE

Supported partially by this lesson topic:

#1.4 Upon completion of this unit the student will be able to plan and estimate for mandays and materials to make telephone cable and power cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook. The mandays for each splice will be estimated in accordance with NAVFAC P-405, Seabee Planner's and Estimator's Handbook and materials estimate will be within ± 5% of an instructor prepared Material Take Off (MTO) for each splice.

ENABLING OBJECTIVE

Supported partially by this lesson topic:

#1.4.2 Upon completion of this topic the student wil be able to plan and estimate for mandays and materials to make power cable splices, workin from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook without deviation. The estimate for materials of each splice will be taken from the appropriate job sheet setting up the procedure for its construction and must be within ± 5% of an instructor prepared Material Take Off (MTO) on that splice.

CRITERION TEST

Upon completion of this topic the student will plan and estimate for mandays and materials to make power cable splices, working from diagrams, specifications, and job sheets provided, using forms and procedures specified in NAVFAC P-405, Seabee Planner's and Estimator's Handbook without deviation. The estimate for materials of each splice will be taken from the appropriate job sheet setting up the procedure for its construction and must be within ± 5% of an instructor prepared Material Take Off (MTO) on that splice.

HOMEWORK:

Read and study Pages 1-1 thru 2-10 and 4-1 thru 4-8 in Seabee Planner's and Estimator's Handbook, NAVFAC P-405.

Note: Tables 4-136, 137, 140.

1.4.2.2

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction		
A. Establish Contact	Introduce self and topic	
B. Establish Readiness	Direct student thinking along desired line.	
C. Establish Effect	Show the student the value of the subject matter to him.	
D. Overview	State topic objective. Explain the method(s) to be used Topic Criterion Exercise: How? When?	
II. Presentation		
A. Make Estimates of Material For a Project	Hand out text, forms, diagrams, specifications, and appropriate job sheet to students.	
1. Material estimates		
a. Used as a basis for material procurement and also as a check to see if material is available		
(1) Sometimes referred to as a Bill of Materials or a Material Take Off		

(2) An error can cause serious delays in a project.

b. Obtain work element quantity

(1) using information on work element estimate work sheets start filling out material estimate work sheet.

(2) List the splices to be made by size and type.

(3) Convert work element quantities into materials required to do the job.

(a) Directly under each work element description show the materials required by type and kind.

(b) In the work element quantity column, show the work element quantity.

(c) In the conversion unit column show the conversion unit. Example - (2 ft. lead sleeve/ ea splice)

(d) In the quantity required column show result of work element quantity times the conversion unit

(e) In required column show special requirements.

c. After computing on work sheets, enter on recap sheets with like material grouped together and totaled.

(1) In description columns, list type of material and breakdown of where used.

(2) In quantity column list quantity for each area.

(3) Total quantity column for each type of material.

(4) In waste and loss factor column show allowance, usually 10%

(5) In waste and loss column show results of multiplying waste and loss factor times total quantity.

Note: If estimates are made directly from prints, use colored pencils to mark over areas of print covered to avoid omissions.

Note: Where possible use Check lists and tables for estimating materials needed and waste and loss factors.

(6) In quantity to procure column enter sum of quantity plus waste and loss.

(7) In remarks column, list any special order details.

d. Heading on material recap worksheets.

(1) Sheet number and number of sheets.

(2) Name of estimator and date.

(3) Name of estimate checker and date.

(4) Unit

(5) Location

(6) Year

(7) Project number

(8) Description of project

B. Make Estimates of Mandays Required For Project

1. Preparing estimate

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Obtain work element quantity from work element estimate.		
b. Select from appropriate table, the mandays per unit figure.		
c. Multiply mandays per unit figure by the quantity to obtain mandays required for work unit.		
d. Work element summary sheet can be used by adding two columns marked "Mandays Per Unit" and "Mandays Required".		
e. Work sheets may be made up to meet needs.		
2. Production Efficiency		
a. Guide Chart		
(1) Production elements		
(2) Areas of evaluation		
b. Graft		
(1) Working minutes per hour		
(2) Delay		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application:		
A. Practical Application Period		
1. Make manday estimate for appropriate splice	Supervise and assist as necessary	
2. Make a material estimate using appropriate job sheet for splice indicated by instructor		
IV. Summary:	Review of important subject matter	Give undivided attention
A. Make Estimates of Material For a Project	Do not introduce new material	
1. Material estimates	Have students to hold all questions until completion of summary	
B. Make Estimates of Mandays Required for Project		
1. Preparing estimate		
2. Production efficiency		Ask questions after completion of summary.
V. Test:	Insure that each student has the appropriate forms, specifications, and job sheets.	Student will demonstrate his knowledge by performing manday and material estimates on appropriate splice as indicated by instructor.
A. Make manday estimate for appropriate splice		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
B. Make a material estimate using appropriate job sheet for splice indicated by instructor.	Inform students they will be performing test without instructor assistance Grade students on a go, no go basis	
VI. Assignment:		
A. Read and study Pages 1-1 thru 2-10 and 4-1 thru 4-8 in Seabee Planner's and Estimator's Handbook, NAVFAC P-405.	Ask oral questions on reading assignment	Participate by answering oral questions.

347

FOR OFFICIAL USE ONLY

STUDENT'S GUIDE
FOR
CONSTRUCTION ELECTRICIANS/POWER & COMMUNICATIONS CABLE SPLICING

CLASS C1 A-721-0023

VOLUME 1 & 2

PREPARED BY

NAVAL CONSTRUCTION TRAINING CENTER
GULFPORT, MISSISSIPPI 39501

PREPARED FOR

CHIEF OF NAVAL TECHNICAL TRAINING
MILLINGTON, TENNESSEE 38054

DATE

23 FEBRUARY 1977

348

FOREWORD

This Student's Guide was developed by the Naval Construction Training Center, Gulfport, Mississippi 39501, as Course Development Manager and is effective upon approval of the Chief of Naval Technical Training.

The Instruction Sheets have been developed and designed to provide information necessary to aid in acquiring the skills necessary to qualify as a Cable Splicing Technician (NEC-5644). The instruction sheets are to be used to supplement lectures, instructor demonstrations, homework assignment, job performance tasks, etc., in acquiring skills as outlined in the course objectives.

The instruction sheets used in this course of instruction are as follows:

Assignment Sheets - Provides specific study instructions identifying paragraphs, pages, and publications. Provides thought-provoking questions on the important portions of the assignment.

Information Sheets - The information includes new concepts, technological updates, and amplifying, corrective, or supplemental information when the technical manuals or other course texts do not contain sufficient related information for instructional purposes.

Job Sheets - Provide job steps for development of job skills where practical work must be performed.

349

TABLE OF CONTENTS

FRONT MATTER PAGE

Foreword i

Table of Contents ii

Safety Notice iv

How To Use This Student's Guide v

ASSIGNMENT SHEETS
1.1.5.1A OPERATION OF BASIC MATHEMATICS

INFORMATION SHEETS

1.1.3.1I GENERAL SAFETY
1.2.1.1I TERMS AND DEFINITIONS
1.2.1.2I TELEPHONE CABLE IDENTIFICATION
1.2.2.1I COLOR CODES
1.2.3.1I DESICCANT
1.3.1.1I TYPES OF POWER CABLE
1.3.8.1I ALUMINUM CABLE AND SPLICES
1.4.1.1I TOOLS, MATERIALS AND EQUIPMENT

JOB SHEETS
1.2.1.1J STRAIGHT SPLICE, LEAD
1.2.1.2J BRIDGE SPLICE, LEAD
1.2.1.3J BUTT SPLICE, LEAD
1.2.2.1J STRAIGHT SPLICE, PLASTIC
1.2.2.2J BRIDGE SPLICE, PLASTIC
1.2.2.3J BUTT SPLICE, PLASTIC
1.2.3.1J JOINING PLASTIC AND LEAD SHEATHED TELEPHONE CABLE - STRAIGHT SPLICE
1.3.1.1J 5 KV (5000 VOLTS) "SCOTCHCAST" 82-SERIES SPLICING KIT INSTRUCTIONS
1.3.2.1J 5 KV RUBBER INSULATED LEAD COVERED JOINT CONSTRUCTION
1.3.3.1J 5 KV SINGLE CONDUCTOR CAPNUT POTHEAD
1.3.4.1J ALL-TAPE SPLICE KIT
1.3.4.2J 3M "SCOTCHCAST" PRINT E-MPD-3
1.3.4.3J "COLLYER" PRINT NO. SR-4; MINE POWER CABLE 5-15 KV, STRAIGHT SPLICE (SHIELDED) 3/C
1.3.5.1J "SCOTCH" K TAPE TERMINATION KITS
1.3.6.1J STRAIGHT TRANSITION SPLICE W/OIL STOP, 5 KV, 1/C, XLP TO VCL
1.3.7.1J 15 KV, SINGLE CONDUCTOR, VCL CABLE, GROUNDED, BRANCH SPLICE

482

JOB SHEETS (CONTINUED)

1.3.8.1J	STRAIGHT SPLICE, 15 KV, XLP, URD, ALUMINUM SPLICING INSTRUCTIONS
1.3.9.1J	15 KV TERMINATION (ALL-TAPE), OUTDOOR WITH RAINSHIELD
1.3.10.1J	ONE WAY-THREE WAY JOINT, THREE CONDUCTOR PILC TO THREE SINGLE CONDUCTOR XLP POWER CABLE
1.3.11.1J	PULLING-EYE ATTACHMENT
1.3.12.1J	LIVE END CAP ON A 15 KV RUBBER-LEAD, 1/C POWER CABLE

493

351

SAFETY NOTICE

CABLE

1. Electrical power cable is not to be used to support chain falls, lifting tackle, or weights of any kind.
2. Scaling, chipping, and wire brushing shall not be performed on power or lighting cable.
3. Power cable is not to be used as ladder rungs for climbing.
4. Work on power, lighting or telephone circuits shall not be performed by other than authorized and qualified personnel.
5. All electrical conductors shall be considered to be carrying current until it has been established beyond doubt that they are dead.

HANDLING HOT SOLDER AND COMPOUNDS

1. Keep furnaces far enough from manhole openings that there will be no possibility of hot metal or compound spilling into the manhold.
2. Never place a cold or wet ladle or other object in molten solder or hot compound.
3. Stand clear when solder and compound are being raised or lowered.
4. Work from above or to one side while soldering.
5. Do not breathe fumes more than necessary.
6. Wear goggles when soldering large joints and tinning lugs and T connections.
7. Do not leave the area of the kettle when heating solder or compounds.

484

352

HOW TO USE THE STUDENT'S GUIDE

This publication has been prepared for your use while a student in the Construction Electricians/ Power and Communications Cable Splicing course. You may make any notes that will help you for your review later in this course, or that will help you when you are on your job at your next duty assignment.

Other publications with which this student's guide was designed to be used include: None

This volume contains the following types of instruction sheets:

Assignment Sheets - For each lesson topic to direct your homework study efforts.

Information Sheets - Which amplify, correct, or supplement the information in the technical manuals or other course text materials.

Job Sheets - Providing job steps for development of job skills where practical work must be performed.

Safety - Note safety notice in Front Matter.

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET 1.1.3.1I

TITLE: GENERAL SAFETY PRECAUTIONS AND FIRST AID

INTRODUCTION

Upon completion of this lesson the student will be able to answer specific oral or written questions regarding key policies governing the safe handling of equipment and materials, consideration for personal safety (including avoiding and eliminating fire hazards); methods of reporting accidents and fires; and, duties and responsibilities of the Class Safety Petty Officer.

REFERENCE

1. Safety Precautions for Shore Activities, NAVMATP-5100, January 1973.
2. First Aid Textbook, Fourth Edition, American Red Cross.

INFORMATION

1. Safety Responsibilities.

   a. The Commanding Officer shall require that persons concerned are instructed and drilled in all applicable safety precautions and procedures, that these are complied with, and that applicable safety precautions, or extracts therefrom, are posted in appropriate places. In any instance where safety precautions have not been issued or are incomplete, he shall issue or augment such safety precautions as he deems necessary, notifying, when appropriate, higher authorities concerned.

   b. It is the responsibility of supervisory personnel to ensure that their subordinates are instructed in and carry out the applicable safety precautions for their work and work areas.

   c. Each individual is responsible for knowing, understanding and observing all safety precautions applicable to his work and work area. In addition, he is responsible for the following:

      (1) Each individual shall report for work rested and emotionally prepared for the tasks at hand.

      (2) He shall use normal prudence in all his functions, commensurate with the work at hand.

      (3) He shall report any unsafe conditions, or any equipment or material which he considers to be unsafe, and any unusual or developing hazards.

INFORMATION SHEET 1.1.3.1I (continued)

(4) He shall warn others whom he believes to be endangered by known hazards or by failure to observe safety precautions, and of any unusual or developing hazards.

(5) He shall report to his supervisor any accident, injury or evidence of impaired health occurring in the course of work.

(6) He shall wear or use the protective clothing and/or equipment of the type required, approved and supplied for the safe performance of his work.

(7) He shall report for work suitably clothed for his assigned tasks.

(a) Suitable clothing is that normally worn by members of the trade or profession.

(b) Certain hair styles and beards are hazardous around machinery and open flame and may interfere with vision or use of breathing devices. They shall be suitably restrained in caps or nets or altered/removed.

(c) Safety shoes or foot protection devices, including non-spark and non-slip shoes shall be worn when hazards so indicate.

(d) Jewelry, loose scarfs and ties shall not be worn when they might subject the wearer to additional hazard.

(e) Individuals requiring eye correction, hearing aid or prosthetic devices to assure prompt perception and avoidance of hazards must use such devices while at work.

2. Electrical Shock and First Aid.

a. Most deaths by electric shock occur due to the fact that safety precautions were not observed.

(1) New men are inclined to expose themselves to hazards due to inexperience; older men because of over-confidence and careless practices.

(2) The majority of deaths occur because of ignorance of the danger of low voltage shock, i.e., 115 volts or less.

b. Conditions needed to cause shock.

(1) A person must be part of a closed circuit in which current can flow.

(2) This circuit must contain a difference in potential.

c. Factors determining severity of shock.

(1) Amount of current that flows through the body.

(a) 0.001 ampere or 1 ma - felt. (one thousandth of an ampere).

(b) 0.01 ampere or 1 ca - loss of muscle control. (one hundredth of an ampere).

(c) 0.1 ampere or 1 da - If 1 second or more - FATAL. (one tenth of an ampere).

d. Effect of body resistance subject to considerable variation.

(1) Thick skin, 100,000 ohms of resistance per square centimeter area.

(2) Thin skin, 10,000 ohms of resistance per square centimeter area.

(3) Wet skin varies from 300 to 1,200 ohms of resistance per square centimeter area.

e. Potential difference (voltage).

(1) Voltages from 30 to 450 volts are by far the most dangerous.

(2) 50% of all fatal accidents by electricity is caused by 120 volts or less.

f. Procedures in recognizing shock victims and removing them from an energized circuit.

(1) Shock comes from a condition in which the circulation of the blood is disturbed.

(2) Shock symptoms:

(a) Skin - pale, cold and moist.

(b) Eyes - vacant, lack luster and dilated pupils.

356

INFORMATION SHEET 1.1.3.11 (continued)

(c) Breathing - shallow and irregular

(d) Pulse weak and rapid

(e) Muscle spasms

(3) How to remove victim from source of electricity.

(a) De-energize or turn off circuit if switch is nearby

(b) If unable to de-energize circuit quickly, pull victim off using any non-conductive material such as:

1. Belt
2. Board
3. Rope

(4) After removal of victim

(a) If victim is still breathing keep him lying down and warm.

(b) Clothing will be loosened to allow for free breathing

(c) DC NOT give any stimulant

(5) If there is any serious bleeding, it must be checked prior to administering further first aid.

(6) If the person is not breathing, artificial respiration must be administered.

(a) Mouth to Mouth resuscitation is the proper method to use.

(b) It must be as soon as possible.

(c) The rate should be about 12 breaths per minute.

(7) If the person's heart beat has stopped you must apply closed chest cardiac massage.

(8) Proper application of cardiac massage.

(a) Place subject on his back and on a firm surface.

(b) Kneel beside subject and place one hand across the breastbone with the heel of the hand resting on the sternum.

(c) Place second hand on top of first with fingers pointing toward the neck.

(d) Rock forward with arms nearly straight so as to transmit your body weight through the arms.

(e) Depress chest just enough to establish a pulse.

(f) Repeat 60 to 80 times per minute.

(g) Precautions:

1. Insure proper hand position to prevent internal injuries.

2. Apply mouth to mouth resuscitation while massaging the heart.

3. If only one operator, interrupt massage every 30 seconds to apply resuscitation for 3 or 4 cycles.

3. Safety Precautions Concerning Fires.

a. Preventing fires - General cleanliness in the entire area is essential for the prevention of fires. In addition, the following requirements are particularly applicable in an area where work with electricity is being carried on:

(1) Avoiding use of flammable cleaning fluids.

(a) Gasoline, benzene, ether, and similar flammable cleaning fluids shall never be used on either energized or deenergized electrical apparatus.

(b) Alcohol shall not be used for cleaning equipment as it damages most types of insulating varnishes.

(c) Alcohol shall never be used for cleaning near electrical equipment from which a spark might be received.

(2) Keeping machinery clean - oil, grease, carbon dust, etc., can become ignited by electrical arcing. Machinery is to be kept absolutely clean and free of all such deposits.

(3) Avoiding open flames - Lighted matches or other open flames shall never be used in confined spaces because of the danger of explosions and fires.

4. Fighting and Reporting Fires.

a. In the event of a fire, the following procedures are to be carried out:

(1) Immediately deenergize electrical circuit or equipment.

(2) Give the alarm

(3) Evacuate the area

(4) Call the Fire Department. In a few cases the means of calling the Fire Department may be much closer at hand than the electric power controls. In such cases the Fire Department should be called first, but circuits should be deenergized before fire fighting begins.

(5) Control the fire insofar as possible with the correct type of firefighting equipment until firefighting personnel arrive.

b. Classification of fires.

(1) Class A - Class A fires are those involving ordinary combustibles such as wood, cloth, paper and the like.

(2) Class B - Class B fires are those involving greases, oils, paints, other flammable petroleum products and flammable liquids in general.

(3) Class C - Class C fires are those involving energized electrical equipment.

(4) Class D - Class D fires are those involving combustible metals.

5. Construction Job Safety

a. Drinking water

(1) Fresh and pure drinking water shall be supplied on every construction job.

(2) Drinking water will be obtained only from sources approved by the public works officer or the officer in charge of construction.

(3) Any one of the following dispensing methods shall be used:

(a) Stationary bubbler with guarded orifice installed on an approved water line.

(b) Fully enclosed water container and individual paper drinking cups.

(c) Portable sanitary drinking fountains which meet current Federal specifications.

(4) Dipping water out of any container by individual cup, dipper, canteen, or other utensil, is prohibited. Containers must be provided with a covering so designed and fastened as to prevent such use.

(5) All containers used to furnish drinking water shall be thoroughly sterilized at least once a week, or more frequently if circumstances require, by methods approved by medical authorities.

b. Temporary toilet facilities

(1) For every 30 persons or less a privy or closet space shall be provided.

(2) It shall be constructed so that the occupant thereof will be shielded from view and protected against the weather and falling objects.

(3) Privies shall be located so as not to contaminate any domestic water supply used for drinking purposes.

(4) They should be so located and banked that surface water cannot flood the pit.

(5) Each privy shall be provided with an adequate urinal trough.

(6) If sewers are available, connections shall be made at once, flush tank closets installed, and running water provided to keep the closet flushed.

INFORMATION SHEET 1.1.3.1I (continued)

(7) At locations where neither a water carriage sewerage system nor chemical toilet is available, the privy or closet space shall contain a fly-tight box constructed over a pit latrine or over pails, or other suitable containers, where pits are impracticable.

c. Personal protection

(1) Clothing and equipment - According to the type of work being done, personnel shall be required to wear chipper's goggles, welder's goggles, welder's shields, hardhats, safety shoes, rubber boots, safety belts, lifelines, life nets, life preservers or jackets, respirators, and other such protective equipment or clothing.

d. Electric wiring and equipment.

(1) Temporary electric wiring and equipment shall be installed and maintained by competent and qualified workmen so as to effectively protect all persons against injury therefrom. Permanent installation should be in accordance with the National Electrical Code..

(2) Grounding equipment - Electrical equipment shall be grounded in accordance with requirements of the National Electrical Code.

(3) Insulation mats - Suitable insulating mats or platforms of substantial construction providing good footing shall be provided and so placed that operators or persons in the vicinity of machines or equipment having exposed live parts of more than 30 volts, cannot readily touch such parts unless standing on these mats or platforms, or on the insulating floor.

(4) Extension Cords - Extension cords of lights and electrically operated tools or devices. together with their connections and fittings, should be of a superior quality. They shall be inspected frequently and be maintained in a safe condition. All extension cords shall be kept dry and free from oil or grease.

6. How to prevent accidents.

a. Good work habits

b. Housekeeping

INFORMATION SHEET 1.1.3.1I (continued)

c. Safety equipment

d. Safety policy

(1) Equipment and materials

(a) Proper use

(b) Proper inspections

(c) Proper storage

7. Reporting Accidents

a. All accidents will be reported no matter how minor.

b. Victim will be sent to the Dispensary/Hospital for treatment.

c. Required accident forms will be filled out by the Instructor/Supervisor.

(1) Accidental Injury/Death Report, OPNAV Form 5100/1.

d. Submit report to Department Safety Supervisor

8. Duties of Class Safety Petty Officer

a. Aid instructor in enforcing safety policies

b. Aid instructor in reporting accidents

c. Insure that proper personnel protective gear is worn by individuals for that working condition.

(1) Hardhat

(2) Ear Plugs

(3) Gloves

(4) Safety shoes

(5) Eye protection

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

ASSIGNMENT SHEET 1.1.5.1A

(TITLE) OPERATION OF BASIC MATHEMATICS

LESSON TOPIC OBJECTIVE

When the student completes this lesson topic a pre-test will have been administered to establish his level of previous training and experience based on the Occupational Standards, NAVPERS 18068D manual for E5 and E6 rating.

STUDY ASSIGNMENT

In the space provided, work out the problems and put the answer in its proper place. This assignment must be completed before the end of the last class today.

STUDY QUESTIONS

1. Addition: Add 5891 + 6495 + 416 =

First put all numbers in their right columns, and find the sum.

$$\begin{array}{r} 5891 \\ 6495 \\ +\ 416 \\ \hline 12802 \end{array} \quad \text{(Example)}$$

a. 123 + 4 + 2346 + 6543 + 205 + 4086

Ans: ________

b. 256 and 279 and 2001 and 35 and 6271

Ans: ________

c. 3561 and 483 and 2461 and 5821 and 186

Ans: 495

2. Subtraction:

Find the difference; subtract 4659 from 9467

9467 Minuend
- 4659 Subtrahend
4808 = Difference or Remainder

a. Take 241 from 540

Ans: ________

b. From 6439 take 287

Ans: ________

c. Subtract 202 from 6432

Ans: ________

3. Multiplication:

Example: Multiply 645 by 36

645 Multiplicand
36 Multiplier
3870 x 6 = Multiplicand
1935 x 3 = Multiplicand
23220 = Product

a. 256 X 35

Ans: ________

b. 231 X 58

Ans: ________

c. 828 X 523

Ans: ________

4. Division:

Example:

$$\text{Divisor } 4 \,/\, \overset{\text{12}}{\overline{48}} \text{ Dividend} \quad (12 \text{ Quotient})$$

a. Divide 7024 by 16

Ans: ________

b. Divide 809 into 16180

Ans: ________

c. 124740 divided by 891

Ans: ________

5. Fractions

a. Addition Example: 1/4 + 7/8 + $\frac{5}{16}$

First find a common denominator

In this case $\frac{}{16}$ 1/4 = $\frac{4}{16}$

Then add up and reduce down to 7/8 = $\frac{14}{16}$

Improper fraction $\frac{5}{16}$

$\frac{23}{16} = 1\frac{7}{16}$

b. $1/2 + 3/4 + 3/8$

Ans: ________

c. $2/3 + \frac{5}{6} + 1/2 + \frac{3}{5}$

Ans: ________

d. Subtraction Example: $7/8 - 1/2$

Again find common denominator. Follow rules for subtraction.

$$\begin{array}{r} 7/8 \\ 1/2 = \frac{4}{8} \\ \hline 3/8 \end{array}$$

e. $5/6 - 4/5$

Ans: ________

f. $2/3 - \frac{1}{6}$

Ans: ________

g. Multiplication of fractions

Example: $2/3 \times \frac{1}{2} =$

Step 1 cancel out when possible

$2/3 \times \frac{1}{2} = \frac{1}{3}$

Ans: ________

366

h. $3/4 \times \frac{4}{7}$

Ans: ________

i. $3/4 \times \frac{12}{27}$

Ans: ________

j. Division of fractions

Example: $3/4 \div 3/8$

Invert 3/8 to $\frac{8}{3}$ and change the sign to multiply

$3/4 \times \frac{8}{3} = \frac{8}{4} = 2$

k. $1\ 1/4 \div \frac{4}{5}$

Ans: ________

l. $5\ 3/4 \div \frac{48}{8}$

Ans: ________

m. Fractions to decimals
Example: Change 1/4 to a decimal
Divide numerator by denominator

```
     .25  = .25
  4 ‾1.00
      8
    ‾‾‾20
      20
    ‾‾‾‾
```

439

n. Change 3/8 to a decimal

Ans: ________

o. Change $\frac{5}{12}$ to a decimal

Ans: ________

p. Change 9/16 to a decimal

Ans: ________

6. Decimals

a. Addition Example:

$$\begin{array}{r} .42 \\ .30 \\ \underline{.28} \\ 1.00 \end{array}$$

NOTE: Keep decimals in straight line

(1) .0276 + .7232 + .3787

Ans: ________

(2) 1.737 + 3.112 + 7.414

Ans: ________

b. Subtraction, find the difference as subtraction just line up decimals

Example:

$$\begin{array}{r} .1414 \\ \underline{-\ .1212} \\ .0202 \end{array}$$

(1) 543.65 - 259.64

Ans: ________

(2) 37.654 - 36.954

Ans: ________

c. Multiplication of decimals

Example: Find the product	.14 x .2	Two places One place
Then count over amount of decimal places	.028	Three places

(1) 6.285 x 17.474

Ans: ________

(2) 9.676 x 11.164

Ans: ________

d. Division of decimals

Example: $.14 \overline{).28}^{\,2}$

Whenever moving the decimal point over in the divisor, over to the right, always move the decimal in the dividend the same amount.

(1) 56.68 divided by 8.72

Ans: ________

(2) 22.5766 divided by 3.14

Ans: ________

7. Squares and Cubes

Example: Square $4^2 = 4 \times 4 = 16$

The Cube is $3^3 = 3 \times 3 \times 3 = 27$

a. 81^2

Ans: ________

b. 13^2

Ans: ________

c. 16^3

Ans: ________

d. 21^3

Ans: ________

8. Areas and Volumes

Example: Area = Length X Width of a rectangle

A = 4' X 8' = 32 sq. feet

Area of a square

$A = 4^2 = 16$ sq. feet

a. 24 inches by 32 inches

Ans: ________

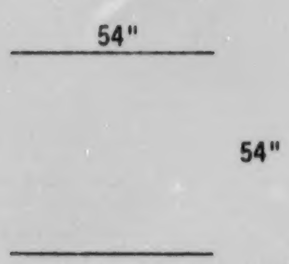
b. 144 feet by 13 feet

Ans: ________

c. Find the area of a square 112 inches X 112 inches

Ans: ________

d. Find the area of



Ans: ________

e. Circular area

Example:

$A = II \quad 2$ Radius 10"

$A = 3.14 \times 10^2$

$A = 3.14 \times 100 = 314$ Sq. inch

f. What is the area of a circle whose radius is .58 inches

Ans: ________

g. What is the area of a circle whose radius is 35.7 inches

Ans: ________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET 1.2.1.1I

(TITLE) TERMS AND DEFINITIONS

INTRODUCTION

These are terms and definitions normally associated with telephone installation and repair. It should increase your knowledge and understanding of telephone cable splicing.

REFERENCE

1. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1

INFORMATION

1. Definitions

   a. Outside cable - Has a variety of sheaths depending on the degree of mechanical, electrical, and corrosional protection required.

   b. Subterranean cable - Buried, lead covered paper-insulated, protected by jute or tape-armored wire

   c. Submarine cable - Lead-covered, paper-insulated, protected by jute twine and steel wire armor

   d. Inside cable - Textile insulated paired cable

   e. Switchboard cable - Silk and cotton, or cotton-insulated, coded, covered with cotton braid impregnated with fire proofing paint. Protected by lead tape.

   f. Coded - Insulation is colored with standard scheme

   g. Composite - Two (2) or more different gage conductors in cable.

   h. Quadded - All or part of conductors arranged in quads or groups of two pairs.

   i. Dry core - Insulation contains no impregnating compound

   k. Exchange cable - Distribution of local circuits from a specified central office

372

INFORMATION SHEET 1.2.1.1I (continued)

l. Toll cable - Provides channels of communication between two widely separated local exchanges

m. Toll entrance cable - Provides exchange with tool circuits from a main toll cable or open wire toll lead

n. Trunk cable - Primarily for connecting two (2) narrowly separated telephone exchanges

o. Post or administrative cable - Part of the administrative telephone system of a post, camp, or station

p. Underground cable - Cable installed underground in conduits

q. Trenched or buried cable - Cable installed beneath the ground without conduit

r. Aerial cable - Cable supported by suspension strand attached to poles

s. Block cable - Cable attached to walls and buildings within a limited area. Aerial cable extending from a pole on which junction with an underground cable is completed and within a limited area may be considered as a block cable.

t. House cable - Cable limited to the confines of a single building or series of related buildings

u. Main or feeder cable - Cable that extends from exchange or central office along main routes to major distribution areas of a city or base.

v. Branch or subsidiary cable - Cable spliced to main cable

w. Lateral cable - A cable extended from a main or branch cable to a single terminal

x. Distribution cable - A cable extended from a terminal to an individual telephone or telephones

y. Distribution terminal - Used for termination of cable pairs for connection to station equipment

z. Cross-connecting terminal - Terminal of which cables are terminated and arranged for jumping or cross-connecting to another cable aa. Outside terminal - Distribution or cross-connecting terminal weatherproof, for exposed locations

ab. House terminal - Distribution or cross-connecting terminal for inside use

ac. Protected terminal - Protected with devices such as fuses and carbon blocks

ad. Underground terminal - Weatherproof terminal used in manhold

2. Terms

a. 2-1 or 3-2 splice - Nomenclatural system for indicating number of cables entering each end of sleeve

b. Bead seam - V-shaped seam in lead sleeve

c. Binder - Distinctively marked string used to tie groups

d. Boarding - Installation of numbered pairs or conductors in a test board

e. Boiling out - Removing moisture by using paraffin

f. Building up the heat - Using solder to sufficiently heat sleeve for rough forming of wipe

g. Cable heads - Short lengths of cable used for connecting incoming cable to distributing frames and terminal strips

h. Cable house - Small building in which cable from one type of plant is spliced to cable from another type of plant

i. Cable transfer - Transfer of conductors from existing to new connections in the same or another cable

j. Choker - Protective cloth wrapping used at sheath ends and at ends of splice opening

k. Cold joint - Joint having the appearance of being wiped with cold solder. Caused by excessive finishing wipes.

l. Crotch plug - Common term for lead wedge

m. Dressing - Rounding and forming ends of sleeve with cable dresser

INFORMATION SHEET 1.2.1.1I (continued)

n. Dry core - Wire used to piece out conductors

o. Drying out - Removing moisture by pouring desiccant (moisture-absorbing powder) over splice

p. Dry ring - Coating on outside of melting pot when paraffin reaches 182°C. or 360°F.

q. Eutectic - Condition of maximum fusibility in a mixture

r. Flux - Substance used to dissolve oxides on surfaces of metals. Stearine is flux commonly used in splicing.

s. Hillup - Applying solder to form mound near the center of a split lead sleeve

t. Layer - Conductors arranged in groups of concentrically placed circles

u. Running a seam - Soldering a split lead sleeve together

v. Section throw - Length of cable is replaced and old cable is spliced to new cable

w. Shim - Strip of cable sheath

x. Shiner - Bare spot on a conductor

y. Sleeve walls - Section of sleeve between the ends of a sleeve

z. Slipping the sleeve - Placing a lead, cotton, or plastic sleeve over one end of conductor or cable to be spliced

aa. Splicing pit - Widened and deepened section of trenched used for housing buried cable splices

ab. Splicing print - Diagram indicating arrangement of cable and splices in a particular area

ac. Stub - Cable used to join main and subsidiary cables

ad. Sweating the joint - Method of joining two metals with soldering iron

ae. Tacking - Using lead droplets to temporarily hold or secure an object

INFORMATION SHEET 1.2.1.1I (continued)

af. Tinning - Initial coating of an object before soldering

ag. Tin runs out - Action that occurs when wiping a joint with improperly mixed solder

ah. Tracer - A distinctively marked group of conductors used to provide a spare circuit for a talking circuit

ai. Universal bad pair - A defective pair formed by joining defective pairs in two (2) or more consecutive lengths of cable

aj. Core - Collective name for all conductors within the cable inclosed within the sheath

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET 1.2.1.2I

(TITLE) TELEPHONE CABLE IDENTIFICATION

INTRODUCTION

Everyone here uses a telephone at some time or another to call home, friends, and to use here on base. To accomplish this, each telephone must have a pair of wires. These wires are identified by tip and ring. This information sheet explains how to identify tip and ring sides of the line in a non-color coded paired telephone cable.

REFERENCE

1. Bell System Practices Plant Series Section 626-020-011, Issue 3 June 1963, AT & TCO Standard Designations for Cable Conductors, Sheaths and Protective Coverings
2. U. S. Army Technical Manual, TM 11-372-1, Pages 3-4 and 3-5

INFORMATION

1. IDENTIFY BY VISUAL INSPECTION THE TYPES OF TELEPHONE CABLE CURRENTLY IN USE BY THE NAVY ASHORE.
    a. The identification of ring and tip cable is used to set a standard in non-color coded cable. This standard is set by the Bell System of American Telephone and Telegraph Company (AT&T Co.).

    b. In non-color coded cable the ring side of the circuit or the ring conductor is always the colored insulated conductor such as green, red, or blue. The tip side of the circuit or tip conductor is always the white insulated conductor.

2. Sheath designation codes and descriptions.
    a. Plain Lead (L) - A lead alloy sheath extruded over the cable core.

    b. Alpeth (A) - An aluminum tape applied longitudinally with an overlap; a coating of asphalt compound is sometimes included and an extruded jacket of polyethylene.

    c. Pap (GI) - Extruded polyethylene over the core; aluminum tape applied longitudinally with an overlap, and an outer extruded jacket of polyethylene.

d. Stalpeth (C^2) - A corrugated aluminum tape applied longitudinally without overlap; a corrugated steel tape with soldered longitudinal seam; a coating of asphalt compound is sometimes included, and an extruded jacket of polyethylene.

e. Pasp (H^3) - Continuous polyethylene jacket applied over the core, wrapped with crepe paper and aluminum tape applied longitudinally without overlap; covered by a tin-coated steel tape having a soldered longitudinal seam, and an outer jacket of polyethylene.

f. Lepeth (D) - Polyethlene jacket applied over the core with an outer covering of lead.

g. Polyethylene Jacket (E) - A jacket of polyethylene extruded over the lead sheath.

h. Polyethylene Jacket Lepeth (F) - A cable having a polyethylene jacket extruded over the lepeth sheath.

3. Outer protection codes and descriptions

a. Jute Protection (JP) - Paper wrapped lead sheath with an outside covering of asphalt impregnated jute.

b. Corrosion Protection (CP) - Two reversed layers of impregnated and reinforced paper and an outer layer of rubber asphalt backed fabric tape.

c. Aerial Tape Armor (AT) - Lead Sheath. A bedding of cutched jute (without asphalt impregnation) applied directly over the lead sheath, and two spiral wrappings of galvanized steel tape armor. Polyethylene Sheath. Two layers of impregnated and reinforced paper; two spiral wrappings of galvanized steel tape armor.

d. Buried Tape Armor (BT) - Lead Sheath. Impregnated paper and cushion of jute; two layers of steel tape and an outer covering of impregnated jute. Polyethylene Sheath. Two layers of impregnated and reinforced paper, two layers of steel tape, and an outer covering of impregnated jute.

e. Gopher Tape Armor (GT) - Impregnated paper, single spiral of steel tape, impregnated paper, outer covering of jute.

f. Modified Tape Armor (MT^2) - A layer of alternate lead and paper tapes, two or three steel tapes, and an outer covering of jute.

INFORMATION SHEET 1.2.1.2I (continued)

g. Light Wire Armor (LA) - Wrapping of jute over a lead sheath followed by a layer of armor wires and an outer covering of two layers of asphalt impregnated jute. Pap Sheath. Cutched jute; layer of galvanized steel wires, and outer layer of impregnated jute.

h. Submarine Single Armor (SA) - Consists of a wrapping of asphalt impregnated jute on a lead sheath, followed by a layer of armor wires and an outer covering of two layers of asphalt impregnated jute.

i. Submarine Double Armor (DA) - Consists of a wrapping of asphalt impregnated jute over a lead sheath, followed by a layer of armor wire, spiralled in the opposite direction, and an outer covering of two layers of impregnated jute.

4. Abbreviations and descriptions of conductor arrangements

a. Pair (PR) - Two strip paper, pulp or plastic insulated wires twisted together.

b. Quad (QD) - Two strip paper, pulp, or plastic insulated pairs twisted together to form a quad.

c. Video (VID) - A special plastic insulated pair with longitudinal and spiral copper taper shields, for video service.

d. Coaxial (COAX) - Bare central conductor with plastic disc insulators and copper tape outer conductor, wrapped with two spiralled steel tape shields.

e. Disc Insulated Quad (DIQD) - Four bare copper conductors equally spaced and insulated by means of notched hard rubber discs, enclosed in a shield made of thin copper and two spiral steel tapes.

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.2.1.1J

(TITLE) STRAIGHT SPLICE, LEAD

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete this assigned splice. Before you proceed READ THE ENTIRE JOB SHEET, and if a kit is used be sure you read the instructions that come with the kit.

Once the splice has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of the insulation to the atmosphere.

Satisfactory telephone cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable practices and proficiency in the use of tools and materials.

REFERENCE

Standard Installation Practices Outside Plant Cable Splicing, TM 11-372-1

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Cable cutter
3. Sharpening stone
4. Lead telephone cable, 26 to 101 pair
5. Scotchcast communications kit or equal
6. Cotton sleeves, 52 to 202 ea., 3/32"
7. Cotton tape, 1/2"
8. Paper pasters
9. Paraffin pot
10. Furnace
11. Lead sleeve
12. 4" wide muslin
13. Solder pot
14. Stearine flux
15. Cotton tape, 1"
16. Paraffin
17. Fuel for furnace
18. Solder, SN 40-60

JOB SHEET 1.2.1.1J (CONTINUED)

JOB STEPS

1. Train and position the cables into their final position or as close as possible, overlaping them for at least 36".

   a. Make bends as large a radius as possible.

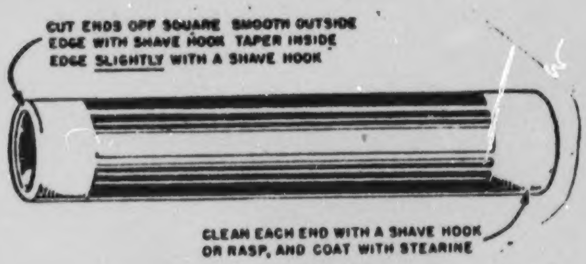
   b. Do not kink cable, make bends gradual.

2. Prepare lead sleeve.

   NOTE: When selecting the sleeve for lead-sheath cable in this class use the tables at the end of this job sheet. You will need to know the pair count and AWG of wire. Assume that it will be made on such equipment as terminals and splice loading coil cases and that no splice-joint material other than the lead sleeve is involved.

   a. Cut sleeve ends squarely.

   b. Bevel edges of each end as shown below.


CUT ENDS OFF SQUARE SMOOTH OUTSIDE EDGE WITH SHAVE HOOK TAPER INSIDE EDGE SLIGHTLY WITH A SHAVE HOOK
CLEAN EACH END WITH A SHAVE HOOK OR RASP, AND COAT WITH STEARINE

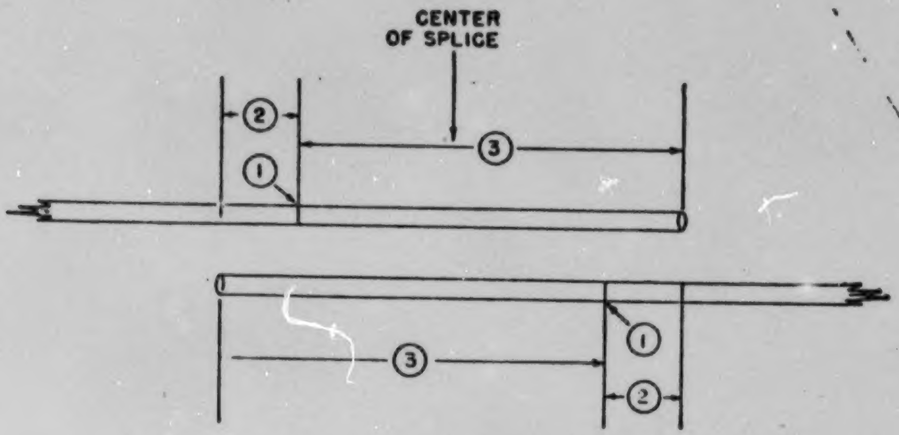
   c. Clean two 3" areas, one at each end of the sleeve as shown above.

   d. Coat cleaned areas with stearine.

   e. Beat down one end until it will just fit over the cable.

3. Measure splice opening.

   a. Determine centerline of opening.


CENTER OF SPLICE
②
①
③
①
③
②

b. Subtract 3" from sleeve length, this will give you the splice opening.

c. Measure half length of opening from each side of centerline, and mark.

4. Ring sheath.

a. Ring sheath at splice-opening marks, proceeding completely around the cable and halfway through the sheath.

b. Ring small cables with knife or shears; ring large cables with chipping knife and hammer.

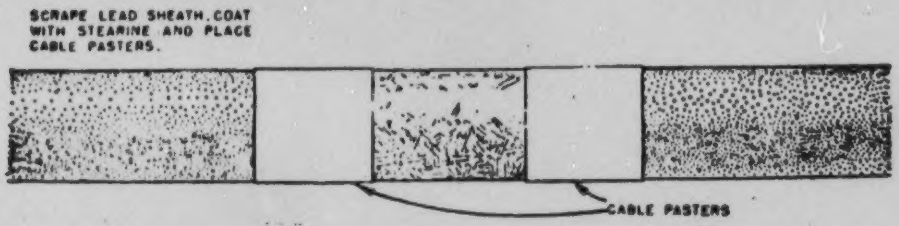
5. Clean and tin sheath.

a. Using card brush or shave hook, clean four inches of the sheath at each end of the splice opening.

b. Inspect cleaned surface, remove any dull spots or streaks that might be present.

c. Coat clean surface with stearine.

d. Perform the tinning as you were shown by the instructor.


SCRAPE LEAD SHEATH. COAT WITH STEARINE AND PLACE CABLE PASTERS.
CABLE PASTERS

JOB SHEET 1.2.1.1J (CONTINUED)

6. Remove lead sheath.

   NOTE: When small cables are being used it is not necessary to split the sheath to remove it. Splitting is used on large cables.

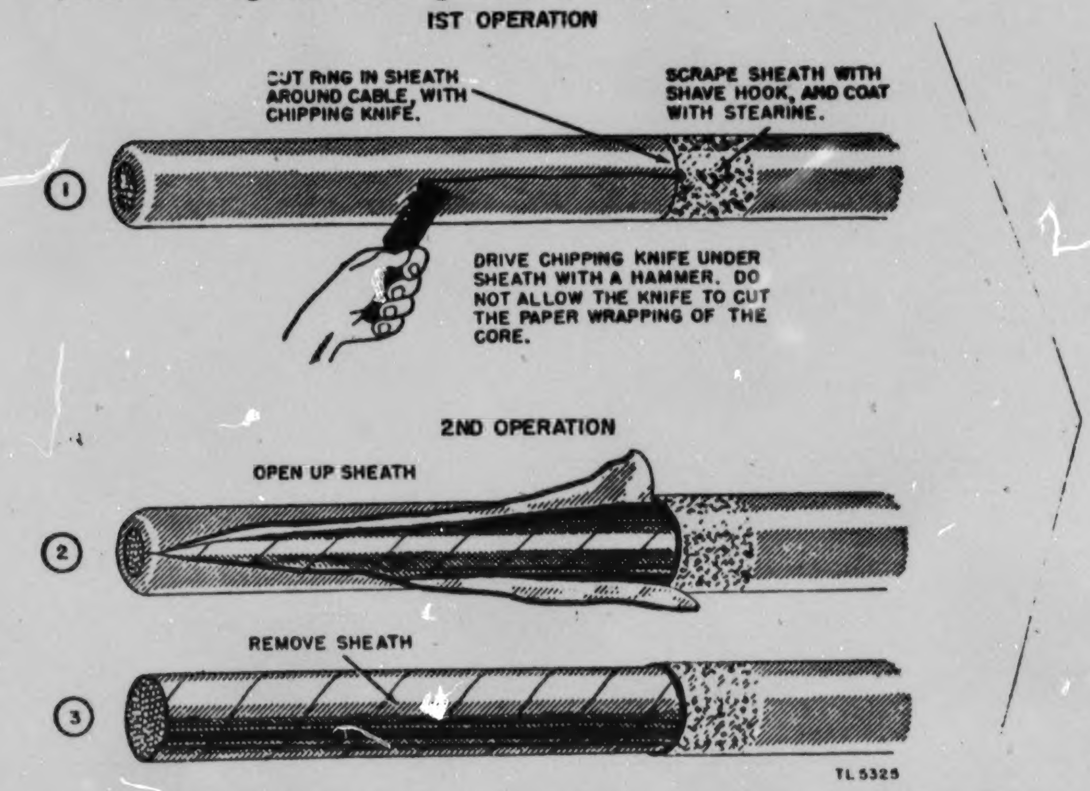
   a. Split sheath with a hammer and chipping knife.

   b. After each blow of the hammer, use knife to pry open sheath slightly.

   c. Make sure chipping knife does not cut core wrapping paper or damage the core in any other way.

   d. Open sheath by turning back upper and lower sheath sections with hammer or "B" cable sheath opener.

   e. Remove sheath by spreading until core is free enough to permit bending and breaking clear of sheath.


1ST OPERATION
CUT RING IN SHEATH AROUND CABLE, WITH CHIPPING KNIFE.
SCRAPE SHEATH WITH SHAVE HOOK, AND COAT WITH STEARINE.
①
DRIVE CHIPPING KNIFE UNDER SHEATH WITH A HAMMER. DO NOT ALLOW THE KNIFE TO CUT THE PAPER WRAPPING OF THE CORE.
2ND OPERATION
OPEN UP SHEATH
②
REMOVE SHEATH
③
TL 5325

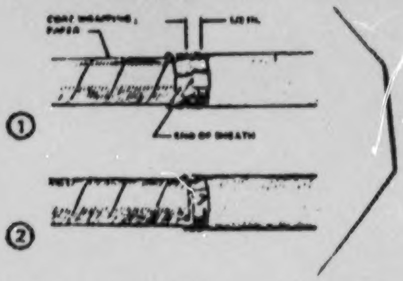
① *Using chipping knife.* ② *Opening sheath.* ③ *Sheath removed.*

7. Cable butt.

   a. Center two layers of dry 1" cotton tape over edge of sheath.

   b. Tuck tape under sheath with scissors of cable butting tool.

   c. If scissors are used, do not damage insulation under sheath.



Butting - tuck method

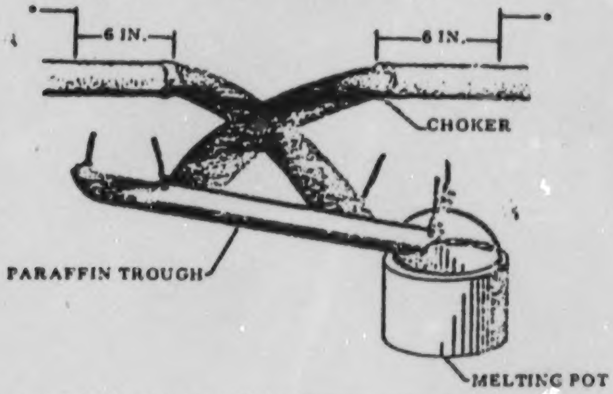
8. Boiling out.

   NOTE: This step is done to prevent absorption of moisture. Boil out conductors with a solution of paraffin or impregnation wax.

   a. Heating the mixture to correct temperature takes little effort.

   b. Bring the paraffin pot up to 375°F to 390°F (191°C to 199°C).

   c. Attach paraffin pan or trough. (see below)



•–STARTING POINTS FOR PARAFFIN POURING

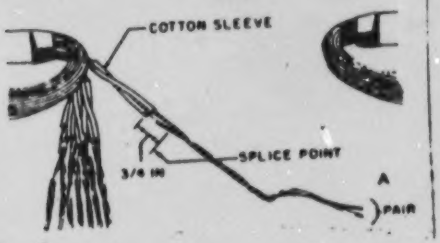
d. Separate pairs to permit the paraffin to pass freely through them. Also, bend them down so that their ends will be below the level of the cable.

e. Start pouring paraffin about six inches back on the sheath. After the sheath is hot, continue pouring the paraffin gradually moving towards the end of the conductors until all moisture is removed.

NOTE: When working under very damp conditions, strip and boil out only one end at a time.

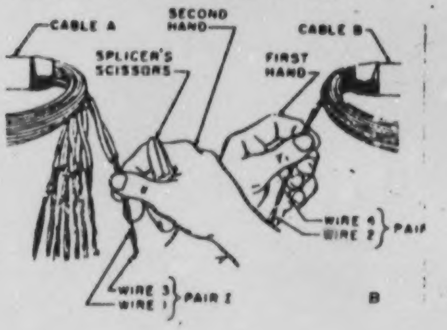
9. Splicing the conductors.

a. Place the sleeves as indicated. Twist the wires of each pair together after placement is completed.


COTTON SLEEVE
SPLICE POINT
3/4 IN
A
PAIR

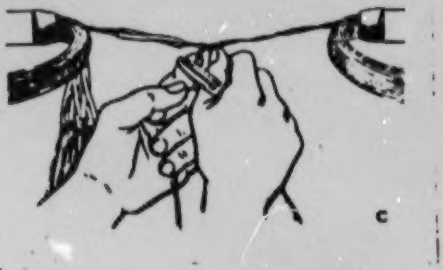
STEP 1

b. Grasp 1 pair of wires in cable A between the thumb and forefinger of the second hand. Grasp another pair of wires (cable B) between the thumb and forefinger of the first hand.


CABLE A
SECOND HAND
CABLE B
SPLICER'S SCISSORS
FIRST HAND
WIRE 4
WIRE 2
PAIR
WIRE 3
WIRE 1
PAIR I
B

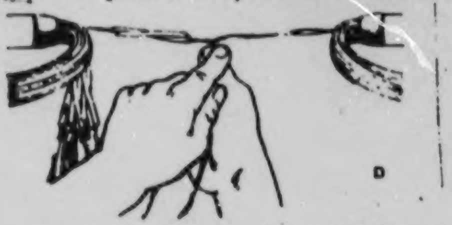
STEP 2

c. Bring both pairs together for splicing allowing enough slack to insure a symmetrical layup of completed splice.



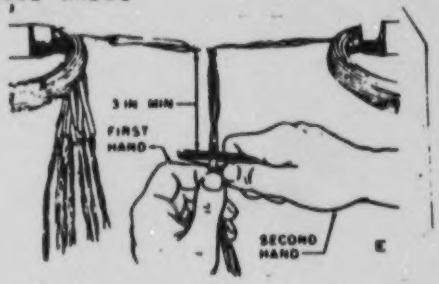
STEP 3

d. Give both pairs a 1/2-turn twist to break the insulation.



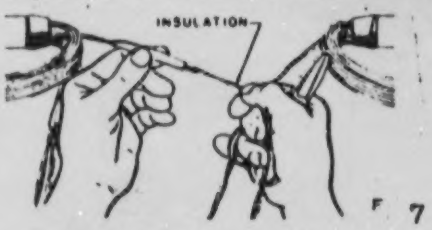
STEP 4

e. Grasp both pairs in the first hand; slide the first hand along both pairs until the proper tail length is reached and cut both pairs with the splicer's scissors. Observe that the tail length is determined by the wire gauge. A three-inch tail is required for 24-gauge wire. A slightly longer tail is required for heavier wire.



STEP 5

f. Use the second and third fingers of the second hand to hold both pairs against the palm of the second hand; grasp the wires just above the twist and remove the insulation. If the insulation will not remove easily, place the wires between the thumb and the back edge of the splicer's scissors. Then pull the insulation from the conductors.

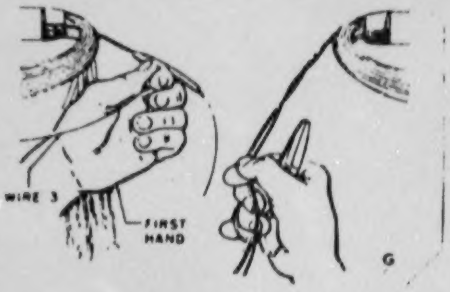


STEP 6

7

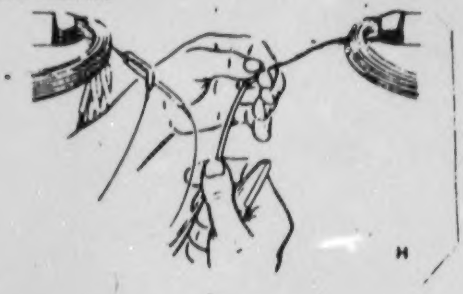
JOB SHEET 1.2.1.1J (CONTINUED)

g. While removing the insulation from the wires with one hand, separate the wires of the other pair as illustrated.



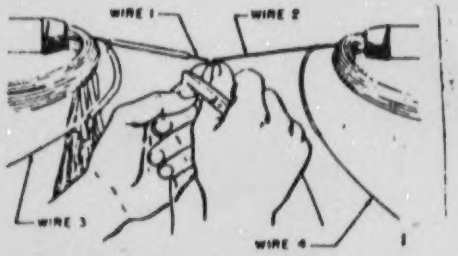
STEP 7

h. Slide the first hand under pair 1 of cable A and allow pair 1 to rest on the first hand. Grasp pair 1 of cable B with the first hand and strip the insulation from the wires with the second hand. With the first hand, grasp the "ring" wire. Push the "tip" wire to the side with the free fingers of the first hand.



STEP 8

i. Grasp the "ring" of cable B with the second hand; draw the wires together and give them a 1/2-turn twist. Include about 1/4-inch insulation of both wires in the twist. This will prevent unfurling.



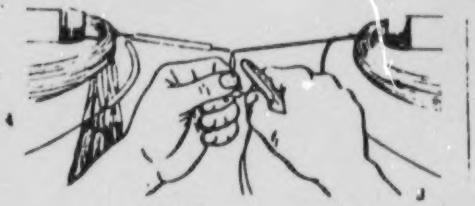
STEP 9

j. Grasp the wires between the thumb and forefinger of the first hand and roll one wire over the other as shown below. Grasp the tails of both wires between the thumb and forefinger of the second hand and bend the tails perpendicular to the section of wires in the first hand. Hold tightly the section of wire in the first hand. Twist the first hand section by cranking with a wrist movement of the second hand, allowing both wires to turn loosely between the thumb and forefinger of the second hand. Continue cranking until a pigtail (twisted section) of 1/2-to 1-inch length is formed.

(1) Continue cranking until the pigtail is forced behind the thumb and forefinger of the first hand. After a little practice, you can make the pigtail by forming several twists with the wires held loosely in the second hand. The finished pigtail should be loosely twisted at the neck and tightly twisted at the free end. Neck looseness reduces the possibility of breakage, and free-end tightness provides good electrical contact.

(2) Crank 19- and 16-gauge wires to form a pigtail with a definite change from looseness to tightness.

(3) Hold both wires especially tight at all times between the thumb and forefinger of the first hand when cranking 26-gauge to 22- or 24-gauge wires and when cranking 24-gauge to 19-gauge wires. If this procedure is not followed, a spiraling of the smaller around the larger wire (not a twisting together of the two wires) will result.

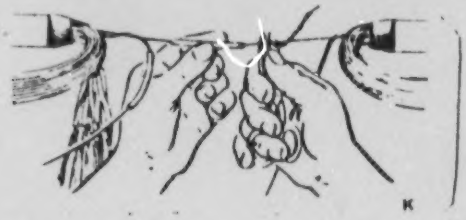


STEP 10

k. Grasp the sleeve with the thumb and forefinger of the first hand. Bend the pigtail to an angle of approximately 45 degrees with the scissors in the second hand. Determine the overall length of the pigtail and determine the length of the tightly twisted end of the pigtail. The overall length should vary from approximately 1 3/8 inches for 24- or 26-gauge conductors to approximately 1 3/4 inches for 16- or 19-gauge conductors.

JOB SHEET 1.2.1.1J (CONTINUED)

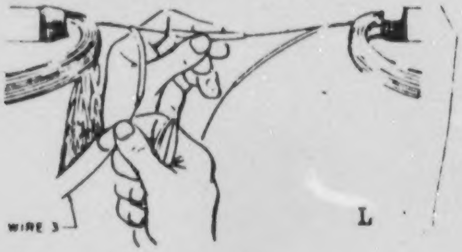
The length of the tightly twisted end should vary from approximately 3/8 inch for 24- or 26-gauge conductors to approximately 1/2 inch for 16- or 19-gauge conductors. Complete the joint by cutting the pigtail to the required length with the scissors held in the second hand.



K

STEP 11

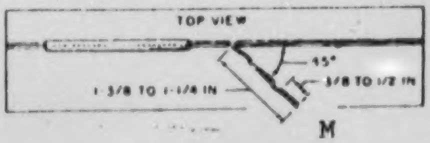
l. Slip the sleeve over the pigtail with the first hand and reach for the "tip" wire with the second hand as shown in the figure. Now, repeat the operations in steps 1 through 12 until all the conductors have been joined.



L

STEP 12

m. To be sure the pigtails you make are good, compare your product with the figure below. Notice the length of the tight turns and the loose turns; observe the square-cut ends and the overall length and straightness of the pigtail. All of these factors are important.



M

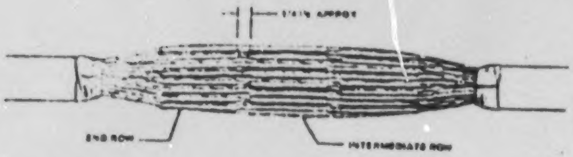
STEP 13

n. Arrange the joints in rows to ensure a proper splice buildup. The number of rows is directly proportional to the splice opening length.

(1) Allow approximately one-fourth inch between adjacent rows.

(2) Do not allow the sleeves of one row to overlap those of another. Arrange the number of sleeves in each row to provide a uniform size for the entire length of the completed splice.

(3) Unless otherwise instructed, locate the end rows the same distance from each end of the splice opening.



STEP 14

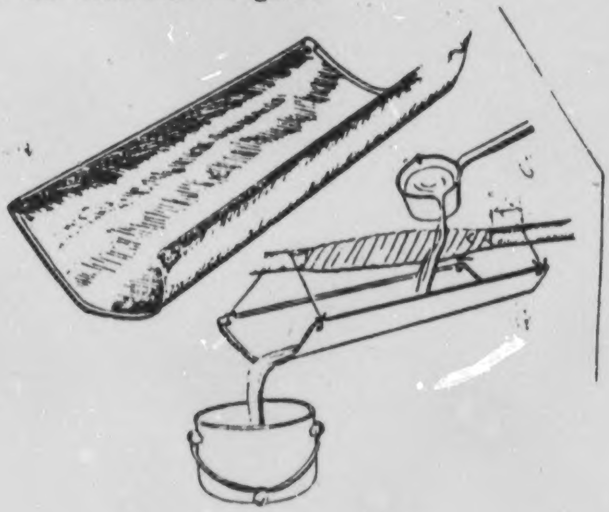
NOTE: When you have completed the pair splicing, it is time to boil the splice out to ensure that all the moisture is out of it.

10. Wrapping the splice.

a. After you boil it out then wrap the splice with 4" muslin starting at the center of the splice.

b. Secure the end of the muslin with a slip knot in the middle.

11. Boiling out the splice for the last time. After the muslin is in place you will boil out the splice once more to be sure that all the moisture is gone.



12. Prepare sheath and sleeve.

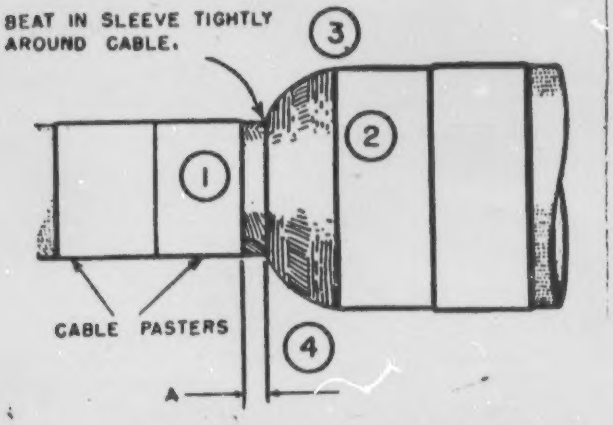
    a. Make sure sheath and sleeve surfaces have been cleaned and stearined.

    b. Position sleeve over splice opening and beat sleeve ends tightly around sheath.

    c. Limit the width of the joint by placing paper pasters around the cable and sleeve. See chart below.

    NOTE: It is recommended that you use two layers of paper pasters on the splice.

Diameter of sleeve (in.)	Distance between beat-in and cable paster on cable, A (in.)
3/4 to 1 3/4	1/4
2 to 4	3/8
4 1/2 to 6	1/2



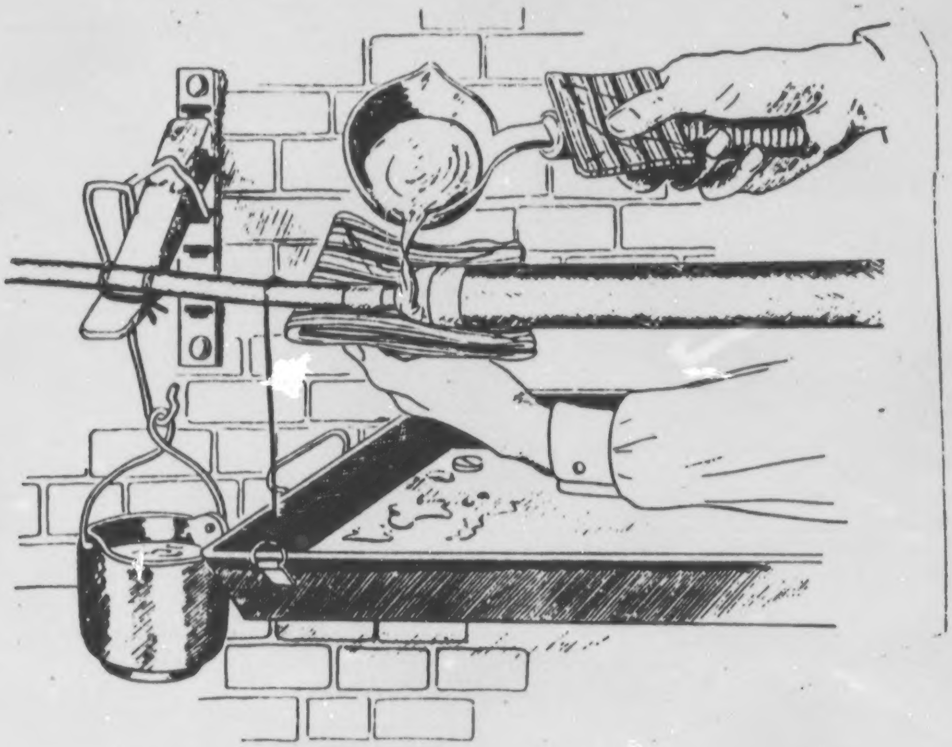
    d. Secure pan trough below joint, this will facilitate the removal of solder drippings by placing a dry newspaper in pan or trough.

    e. Place necessary wiping cloths at a convenient location.

13. Wiping the sleeve.

    a. Hold catch cloth slightly below joint.

b. Pour one ladle of solder slowly over sheath and sleeve, moving the ladle in a circular motion at all times.



HOLDING THE FINISHING CLOTH

NOTE: As you are heating up the joint it is a very good idea to keep pouring the hot solder from the catch cloth back into the ladle. This will help to cool it down.

c. Raise catch cloth so the side edges touch pasters, maintaining center of cloth in shape of a cup or pocket.

d. Continue pouring solder, distributing it over the top and sides of the joint.

e. Insure uniform distribution of solder over the joint, and when it gets mushy, bring it up to the top of the splice.

f. Make sure that all pairs of the joint are well heated with solder. DO NOT OVER HEAT.

g. With the solder in the catch cloth form and pack the joint.

h. By using the wiping cloth make the final three wipes.

JOB SHEET 1.2 1.10 (continued)

14. Testing the splice.

a. Remove about 18" of the sheath from each end of the splice. This will be used for testing.

b. Using TS-420/U, Telephone Test Set or equivalent (76C), test all the conductors for tone.

INSTRUCTOR'S INITIALS ____________

TABLE 9-1. STANDARD LEAD SLEEVE SIZES

INSIDE DIAMETER (IN.)	LENGTH (IN.)
I. NORMAL WALL THICKNESS	
3/4	15
1	15
1 1/4	15
1 1/2	16
1 3/4	17
2	17
2 1/4	17
2 1/2	20
2 3/4	20
3	20
3 1/4	20
3 1/2	20
3 3/4	20
4	20
4 1/2	20 and 22
5	22
5 1/2	22
6	22
6 1/2	22
7	22
II. EXTRA-STRENGTH WALL THICKNESS	
5	22
5 1/2	22
6	22
6 1/2	22
7	22

TABLE 9-II. LEAD-SHEATHED, PAIRED CABLE: STRAIGHT SPLICE

Size of cable (No.Prs)	GAUGE OF CABLE							
	19		22		24		26 or 28	
	SIZE OF SLEEVE							
	D	L	D	L	D	L	DD	L
6	3/4	15						
11	1	15*	1	15*	1	15*	1	15*
16	1	15*	1	15*	1	15*	1	15*
26	1 1/4	15	1 1/4	15*	1	15*	1	15*
51	1 3/4	17*	1 1/2	15*	1 1/4	15*	1 1/4	15*
76	1 3/4	17	1 3/4	17*	1 1/2	15*	1 1/2	15*
101	2 1/4	17*	1 3/4	17*	1 3/4	17*	1 1/2	15*
152	2 1/4	17	2	17*	2	17*	1 3/4	17*
202	2 3/4	20	2 1/4	17*	2	17	2	17*
303	3 1/2	20	2 1/4	20*	2 1/2	20*	2	17
404	4	20*	3	20	3	20*	2 1/2	20*
455	4 1/2	20*	3	20				20
606			3 1/2	20	3 1/2	20*	3	20
909			4 1/2	20	4 1/2	20*	3 1/2	20
1212					5	20*	4 1/2	20*
1515					5 1/2	20*	5	20*
1818							5	20*
2121							5	20

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

TABLE 9-III. LEAD-SHEATHED, 19-GAUGE, PAIRED CABLE: BRIDGE SPLICE: MAIN CABLE NOT CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO. PRS)													
	11 or 16		26		51		76		101		152		202	
	SIZE OF SLEEVE													
(No.prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L
26	1 1/2	15	1 3/4	17*										
51	1 3/4	17*	2	17*	2 1/4	17*								
76	1 3/4	17*	2	17*	2 1/4	17*								
101	2	17	2 1/4	17*	2 1/2	20*								
152	2 1/2	20*	2 1/2	20*	2 3/4	20*	3	20*						
202	2 1/2	20	2 3/4	20*	3	20*	3	20*	3 1/2	20*				
303	3	20	3	20	3 1/2	20*	3 1/2	20*	4	20*	4 1/2	22*		
404	3 1/2	20	3 1/2	20	4	20	4 1/2	22*	4 1/2	22*	5	22*	5	22*
455	3 1/2	20	3 1/2	20	4	20	4 1/2	22*	3 1/2	22	5	22*	5 1/2	22*

D = Diameter in inches
L = Length in inches
* = If paraffin is used, select sleeve of next smaller diameter

TABLE 9-IV. LEAD-SHEATHED, 22-GAUGE, PAIRED CABLE: BRIDGE SPLICE; MAIN CABLE NOT CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO. PRS)															
	11 or 16		26		51		76		101		152		202		303	
	SIZE OF SLEEVE															
(No. prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
26	1 1/2	15*	1 1/2	15												
51	1 1/2	15	1 1/2	15	1 3/4	17										
76	1 3/4	17*	1 3/4	17*	2	17*	2	17								
101	1 3/4	17	1 3/4	17	2	17	2 1/4	17*	2 1/4	17						
152	2	17*	2	17	2 1/4	17	2 1/2	20*	2 1/4	20						
202	2 1/4	17*	2 1/2	20*	2 3/4	20*	2 3/4	20*	2 3/4	20	3	20*				
303	2 1/2	20*	2 1/2	20	2 3/4	20	2 3/4	20	3	20	3 1/2	20*				
404	2 3/4	20*	2 3/4	20	3	20*	3	20	3 1/2	20	3 1/2	20	4	20*		
455	2 3/4	20	3	20*	3	20*	3 1/2	20*	3 1/2	20	4	20*	4 1/2	22*		
606	3	20	3	20	3 1/2	20*	3 1/2	20	4	20*	4 1/2	22*	4 1/2	22*	4 1/2	22
909	3 1/2	20	3 1/2	20	4	20*	4	20	4	20	4 1/2	22	5	22*	5	22

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

TABLE 9-V. LEAD-SHEATHED, 24-GAUGE, PAIRED CABLE: BRIDGE SPLICE; MAIN CABLE NOT CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO.PRS)															
	11 or 16		26		51		76		101		152		202		303	
	SIZE OF SLEEVE															
(No.Prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
26	1 1/4	15	1 1/2	15*												
51	1 1/2	15*	1 1/2	15	1 3/4	17*										
76	1 1/2	15	1 3/4	17*	1 3/4	17	2	17*								
101	1 1/2	15	1 3/4	17	2	17*	2	17	2 1/4	17						
152	1 3/4	17	1 3/4	17	2	17	2 1/4	17*	2 1/2	20*	3 1/2	20				
202	2	17	2	17	2 1/4	17	2 1/2	20*	2 3/4	20*	2 3/4	20*	3	20*		
303	2 1/4	17	2 1/4	17	2 1/2	20	2 3/4	20*	2 3/4	20*	3	20*	3 1/2	20*	3 1/2	20
404	2 1/2	20	2 1/2	20	3	20*	3	20*	3	20	3 1/2	20*	4	20*	4	20*
606	2 3/4	20	2 3/4	20	3	20	3 1/2	20*	3 1/2	20	4	20*	4	20	4 1/2	22*
909	3 1/2	20	3 1/2	20	3 1/2	20	4	20*	4	20*	4 1/2	22*	4 1/2	22*	4 1/2	22
1212							4	20	4 1/2	22	4 1/2	22*	4 1/2	22	5	22
1515															5 1/2	22*

D = Diameter in Inches.
L = Length in Inches.
* = If paraffin is used, select sleeve of next smaller diameter.

TABLE 9-VI. LEAD-SHEATHED, 26- or 28-GAUGE, PAIRED CABLE: BRIDGE SPLICE: MAIN CABLE NOT CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO. PRS)															
	11 or 16		26		51		76		101		152		202		303	
	SIZE OF SLEEVE															
(No. prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
26	1	15	1 1/4	15												
51	1 1/4	15	1 1/2	15*	1 1/2	15*										
76	1 1/2	15*	1 1/2	15*	1 1/2	15	1 3/4	17*								
101	1 1/2	15*	1 1/2	15*	1 3/4	17*	1 3/4	17*	2	17*						
152	1 3/4	17*	1 3/4	17*	2	17*	2	17*	2	17	2 1/4	17*				
202	1 3/4	17	1 3/4	17	2	17	2 1/4	17*	2 1/2	20*	2 1/2	20*	2 3/4	20*		
303	2	17	2	17	2 1/4	17	2 1/2	20*	2 1/2	20	2 3/4	20*	2 3/4	20	3	20*
404	2 1/4	17	2 1/4	17	2 1/2	20*	2 1/2	20	2 3/4	20*	3	20*	3	20	3 1/2	20*
606	2 1/2	20	2 1/2	20	2 3/4	20	3	20	3 1/2	20*	3 1/2	20	3 1/2	20	[illegible]	20*
909	2 3/4	20	2 3/4	20	3	20	3 1/2	20*	3 1/2	20	4	20*	4	20	4 1/2	22*
1212	--	--	--	--	--	--	3 1/2	20*	4	20*	4	20	4 1/2	22*	4 1/2	22
1515	--	--	--	--	--	--	--	--	--	--	--	--	4 1/2	22	5	22
1818	--	--	--	--	--	--	--	--	--	--	--	--	4 1/2	22	5	22*
2121	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5 1/2	22*

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

TABLE 9-VII. LEAD-SHEATHED, 19-GAUGE, PAIRED CABLE: BRIDGE SPLICE; MAIN CABLE CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO. PRS)															
	11 or 16		26		51		76		101		152		202		303	
	SIZE OF SLEEVE															
(No. prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
11 or 16	1 1/2	15*														
26	1 1/2	15	1 3/4	17*												
51	1 3/4	17	2	17*												
76	2	17*	2 1/4	17*	2 1/4	17*	2 1/2	20*								
101	2 1/4	17*	2 1/4	17*	2 1/2	20*	2 1/2	20	2 3/4	20*						
152	2 1/2	20	2 1/2	20	2 3/4	20*	3	20*	3	20*	3	20*				
202	3	20*	3	20*	3	20*	3	20	3 1/2	20*	3 1/2	20	4	20*		
303	3 1/2	20	3 1/2	20	4	20	4	20*	4	20*	4 1/2	22*	4 1/2	22*	4 1/2	22

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

400

TABLE 9-VIII. LEAD-SHEATHED, 22-GAUGE, PAIRED CABLE: BRIDGE SPLICE; MAIN CABLE CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO. PRS) / SIZE OF SLEEVE: 11 Or 16		26		51		76		101		152		202		303	
(No. prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
11 or 16	1 1/4	15														
26	1 1/2	15*	1 1/2	15												
51	1 1/2	15	1 1/2	15	1 3/4	17										
76	1 3/4	17*	1 3/4	17*	2	17*	2	17								
101	1 3/4	17	2	17*	2	17	2 1/4	17*	2 1/4	17*						
152	2	17	2 1/4	17*	2 1/4	17	2 1/2	20*	2 1/2	20	2 3/4	20*				
202	2 1/4	17*	2 1/2	20*	2 3/4	20*	2 3/4	20*	2 3/4	20*	3	20*	3	20		
303	2 3/4	20	2 3/4	20	3	20*	3	20	3 1/2	20*	3 1/2	20*	3 1/2	20	4	20*

D = Diameter in inches
L = Length in inches
* = If paraffin is used, select sleeve of next smaller diameter

539

538

TABLE 9-IX. LEAD-SHEATHED, 24-GAUGE, PAIRED CABLE: BRIDGE SPLICE; MAIN CABLE CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO. PRS)																	
	11 or 16		26		51		76		101		152		202		303	
	SIZE OF SLEEVE																	
(No. prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
11 or 16	1 1/4	15																
26	1 1/4	15	1 1/2	15*														
51	1 1/2	15*	1 1/2	15	1 3/4	17*												
76	1 1/2	15	1 3/4	17*	1 3/4	17	2	17*										
101	1 3/4	17*	1 3/4	17	2	17*	2	17*	2 1/4	17*								
152	2	17*	2	17*	2 1/4	17*	2 1/4	17*	2 1/2	20*	2 1/2	20						
202	2 1/4	17*	2 1/4	17*	2 1/2	20*	2 1/2	20*	2 3/4	20*	2 3/4	20	3	20*				
303	2 1/2	20*	2 1/2	20*	2 3/4	20*	2 3/4	20*	3	20*	3	20*	3 1/2	20*	3 1/2	20		

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

JOB SHEET 1.2.1.1J (CONTINUED)

TABLE 9-X. LEAD-SHEATHED, 26- or 28-GAUGE, PAIRED CABLE: BRIDGE SPLICE; MAIN CABLE CUT

Size of main cable	SIZE OF BRIDGE CABLE (NO. PRS)															
	11 or 16		26		51		76		101		152		202		303	
	SIZE OF SLEEVE															
(No. prs)	D	L	D	L	D	L	D	L	D	L	D	L	D	L	D	L
11 or 16	1 1/4	15*														
26	1 1/4	15*	1 1/4	15*												
51	1 1/4	15	1 1/2	15*	1 1/2	15*										
76	1 1/2	15*	1 1/2	15*	1 1/2	15	1 3/4	17*								
101	1 1/2	15*	1 1/2	15*	1 3/4	17*	1 3/4	17*	2	17*						
152	1 3/4	17*	1 3/4	17*	2	17*	2	17*	2	17	2 1/4	17*				
202	2	17*	2	17*	2 1/4	17*	2 1/4	17*	2 1/2	20*	2 1/2	20*	2 3/4	20*		
303	2 1/4	17*	2 1/4	17*	2 1/4	17	2 1/2	20*	2 1/2	20	2 3/4	20*	2 3/4	20	3	20*

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

403

TABLE 9-XI. LEAD-SHEATHED, 16-GAUGE PAIRED CABLE AND QUADDED CABLE: STRAIGHT SPLICE

DIAMETER OF MAIN CABLE (IN.)	SIZE OF LEAD SLEEVE	
	D	L
3/4	1 1/2	15*
1	1 3/4	17*
1 1/4	2	17*
1 1/2	2 1/2	20*
1 3/4	2 3/4	20*
2	3	20*
2 3/8	4	20*
2 5/8	4 1/2	20*

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

JBO SHEET 1.2.1.1J (CONTINUED)

TABLE 9-XII. LEAD-SHEATHED, 16-GAUGE, PAIRED CABLE AND QUADDED CABLE: BRIDGE SPLICE

Diameter of main cable (in.)	DIAMETER OF BRIDGE CABLE (IN.)									
	3/4		1		1 1/4		1 1/2		1 3/4	
	SIZE OF SLEEVE									
	D	L	D	L	D	L	D	L	D	L
3/4	2	17*								
1	2 1/4	17*	2 3/4	20*						
1 1/4	2 1/4	17*	3	20*	3	20*				
1 1/2	3	20*	3	20*	3	20*	3 1/2	20*		
1 3/4	3	20*	3 1/2	20*	3 1/2	20*	4	20*	4	20*
2	3 1/2	20*	3 1/2	20*	4	20*	4	20*	4 1/2	22*
2 3/8	4	20*	4	20*	4	20*	4 1/2	22*	4 1/2	22*
2 5/8	5	22*	5	22*	5	22*	5 1/2	22*	5 1/2	22*

	Diameter of bridge cable (in.)					
	2		2 1/4		2 5/8	
	SIZE OF SLEEVE					
2	4 1/2	22				
2 1/4	5	22*	5	22*		
2 5/8	6	22*	6	22*	6	22*

D = Diameter in inches.
L = Length in inches.
* = If paraffin is used, select sleeve of next smaller diameter.

TABLE 9-XIII. AUXILIARY LEAD SLEEVES FOR PLASTIC-SHEATHED CABLE: INSIDE SLEEVE DIAMETERS*

No. of pairs	INSIDE SLEEVE DIAMETER (In.)			
	19-gauge cable	22-gauge cable	24-gauge cable	26-gauge cable
16	1			
26	1 1/4			
76	1 3/4			
101	1 3/4			
152	2 1/4	1 3/4		
202	2 1/4	1 3/4	1 1/2	
303	2 3/4	2 1/4	1 3/4	1 1/2
404	3	2 1/4	1 3/4	1 3/4
455	3	2 1/2	---	---
606		2 3/4	2 1/4	2
909		3	2 1/2	2 1/4
1212			3	2 1/2
1515			3	2 3/4
1818				3
2121				3

* When estimating the lead-wedge size needed at Y joints, add 1/4 inch to the diameters listed in the table. The resultant figure equals the approximate outside diameter of the auxiliary sleeve.

TABLE 9-XIV. LEAD SLEEVES FOR SPLICES IN TERMINAL POSTS; 19-, 22-, 24-, and 26-GAUGE CABLE

Cable size (prs)	INSIDE DIAMETER OF SLEEVE				
	SLEEVE LENGTH (IN.)	19-GAUGE CABLE (IN.)	22-GAUGE CABLE (IN.)	24-GAUGE CABLE (IN.)	26-GAUGE CABLE (IN.)
6, 11, or 16	9	1 1/2	1 1/4	1	
26	9	1 3/4	1 1/2	1 1/4	1
51	9	2	1 3/4	1 1/2	1 1/4
76	9	2 1/4	2	1 3/4	1 1/2
101	9	2 3/4	2	2	1 3/4
152	9	---	2 1/2	2 1/2	2
202	9	---	3	2 3/4	2 1/2
303	9	---	---	---	2 3/4
404	9	---	---	---	3

TABLE 9-XV. LEAD SLEEVES FOR SPLICES WITH SPLICE LOADING COIL CASES

CABLE DIAMETER (IN.)	CABLE CIRCUMFERENCE (IN.)	NO. PROGRAM CASES	LEAD SLEEVE SIZES IN SECTION D L (IN.)	LEAD SLEEVE SIZES AT STRAIGHT SPLICE D L (IN.)
1 1/4 to 1 3/4	4 to 5 1/2	4 or 6	4 1/2 x 20	4 1/2 x 20
		2	3 1/2 x 20	4 x 20
1 3/4 to 2 1/4	5 1/2 to 7	4 or 6	5* x 20	5 x 22*
		2	4 x 20	4 1/2 x 20
2 1/4 to 2 5/8	7 to 8 1/4	4 or 6	5* x 22	5 1/2 x 22*
		2	4 1/2 x 20	5 x 22*
3 1/8	9 3/4	6	5 1/2* x 22	6 x 22*

* If cable is maintained under continuous pressure, use lead sleeve of extra-strength wall thickness and place aerial cable supports (Part 1) on cable near each end of sleeve.

TABLE 9-XVI. LEAD SLEEVES FOR DISK SPLICES: INSIDE SLEEVE DIAMETERS

DISK NO.	INSIDE DIAMETER OF LEAD SLEEVE (IN.)	
	OPEN-HOLE DISK IN SLEEVE	CLOSED-HOLE DISK IN SLEEVE
3-152	4	4 1/2
2-202-A	4	4 1/2
3-202	3 1/2	4
4-152	3 1/2	4
3-303	4 1/2*	4 1/2
4-202-A	4 1/2*	4 1/2
4-303	5 *	5
6-152-C	4 1/2*	----
6-152-R	----	5
6-202-C	5 *	----
6-202-R	----	5 1/2
6-303-C	5	----
6-303-R	----	6
9-202-C	5 1/2	----
9-202-R	----	6
5-202-A	5 *	5
2121-A	5	6
2121-B	5	6
7-202-AC	5 1/2	----
5-303	5 1/2	6
7-303	5 1/2	6
3-404-A	5 1/2*	6
3-404-B	5 1/2*	6
4-404-A	5 1/2	6
5-404-A	5 1/2	6

*If paraffin is used, select sleeve of next smaller diameter.

JOB SHEET 1.2.1.1J (CONTINUED)

TABLE 9-XVII. LEAD SLEEVES FOR DUCT SPLICES WITH 3 1/4-INCH COTTON SLEEVES

SIZE OF CABLE (PRS)	GAUGE	LEAD SLEEVE SIZE (IN.)		ROWS OF COTTON SLEEVES
		D	L	
303	19	2 3/4	31 1/2	7
455	19	2 3/4	49	12
404	22	2 1/2	31 1/2	7
605	22	2 3/4	28	6
909	22	2 3/4	59 1/2	15
404	24	2 1/4	31 1/2	7
606	24	2 1/2	31 1/2	7
909	24	2 3/4	35	8
1212	24	2 3/4	49	12
1515	24	2 3/4	70	18
606	26	2 1/4	31 1/2	7
909	26	2 1/2	31 1/2	7
1212	26	2 3/4	35	8
1215	26	2 3/4	42	10
1818	26	2 3/4	59 1/2	15
2121	26	2 3/4	70	18

JOB SHEET 1.2.1.1J (CONTINUED)

TABLE 9-XVIII. LEAD SLEEVES FOR DUCT SPLICES WITH 2 1/2-INCH COTTON SLEEVES

SIZE OF CABLE (PRS)	GAUGE	LEAD SLEEVE SIZE (IN.)		ROWS OF COTTON SLEEVES
		D	L	
455	19	2 3/4	40	12
909	22	2 3/4	48	15
909	24	2 3/4	29	8
1212	24	2 3/4	40	12
1515	24	2 3/4	56 1/2	18
1212	26	2 3/4	29	8
1515	26	2 3/4	34 1/2	10
1818	26	2 3/4	48	15
2121	26	2 3/4	56 1/2	18

TABLE 9-XIX. LEAD SLEEVES FOR 0.375-INCH COAXIALS

CABLE MAKEUP		SLEEVE SIZES	
NO. OF COAXIAL PAIRS	NO. OF LAYERS PAPER-INSULATED QUADS	D (IN.)	L (IN.)
4	0	4 1/2	25
4	1	5 *	25
4	2	5 1/2*	25
6	0	5	25
6	1	5 1/2*	25
6	2	6 *	25
8	0	5 1/2	25
8	1	6 *	25
8	2	6 1/2*	25

* If paper-insulated quads are loaded, increase sleeve diameter 1/2 inch.

TABLE 9-XX. LEAD SLEEVES FOR STRAIGHT SPLICES OF ALUMINUM CONDUCTOR CABLES

SIZE OF CABLE (PR)	CABLE GAUGE					
	17		20		22	
	D (IN.)	L (IN.)	D (IN.)	L (IN.)	D (IN.)	L (IN.)
6	1	15				
11	1 1/4	15	1	15		
16	1 1/4	15	1 1/4	15	1	15
26	1 1/2	15	1 1/2	15	1 1/2	15
51	2	17	1 3/4	15	1 1/2	15
76	2 1/2	20	2	17	1 3/4	17
101	2 3/4	20	2 1/2	17	2	17
152	3 1/2	20	2 1/2	17	2 1/2	17
202	4	20	3	20	2 1/2	20
303	----	--	3 1/2	20	3	20
404	----	--	4	20	3 1/2	20
455	----	--	4 1/2	20	---	--
606	----	--	---	--	4	20
909	----	--	---	--	5 1/2	20

411

412

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.2.1.2J

(TITLE) BRIDGE SPLICE, LEAD

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete this assigned splice. Before you proceed READ THE ENTIRE JOB SHEET, and if a kit is used be sure you read the instructions that come with the kit.

Once the splice has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of the insulation to the atmosphere.

Satisfactory telephone cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable practices and proficiency in the use of tools and materials.

REFERENCE

Standard Installation Practices Outside Plant Cable Splicing, TM 11-372-1

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Cable cutter
3. Sharpening stone
4. Lead telephone cable, 26 to 101 pair
5. Scotchcast communications kit or equal
6. Cotton sleeves, 52 to 202 ea., 1/4"
7. Cotton tape, 1/2"
8. Paper pasters
9. Paraffin pot
10. Furnace

JOB SHEET 1.2.1.2J

11. Lead sleeve

12. 4" wide muslin

13. Solder pot

14. Stearine flux

JOB STEPS

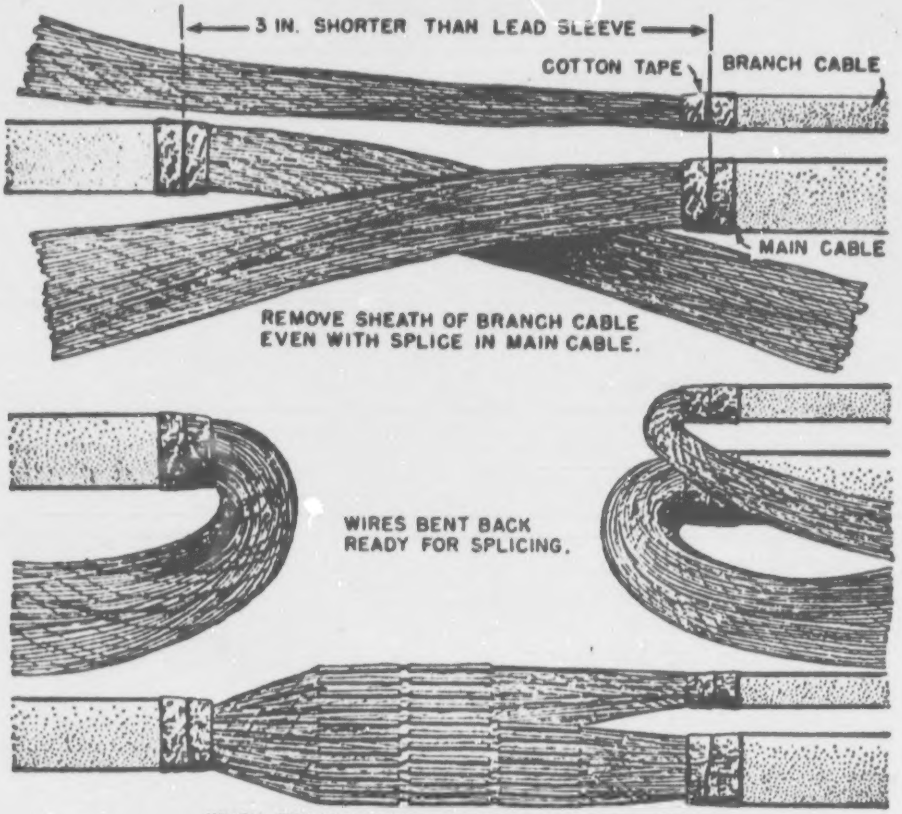
1. Prepare lead sleeve. (Do steps 1 through 8 of Job Sheet 1.2.1.1J, Straight Splice, Lead, then proceed with this Job Sheet.)

2. Select the proper lead wedge and tack it to the cable sheaths using the prestlight torch.

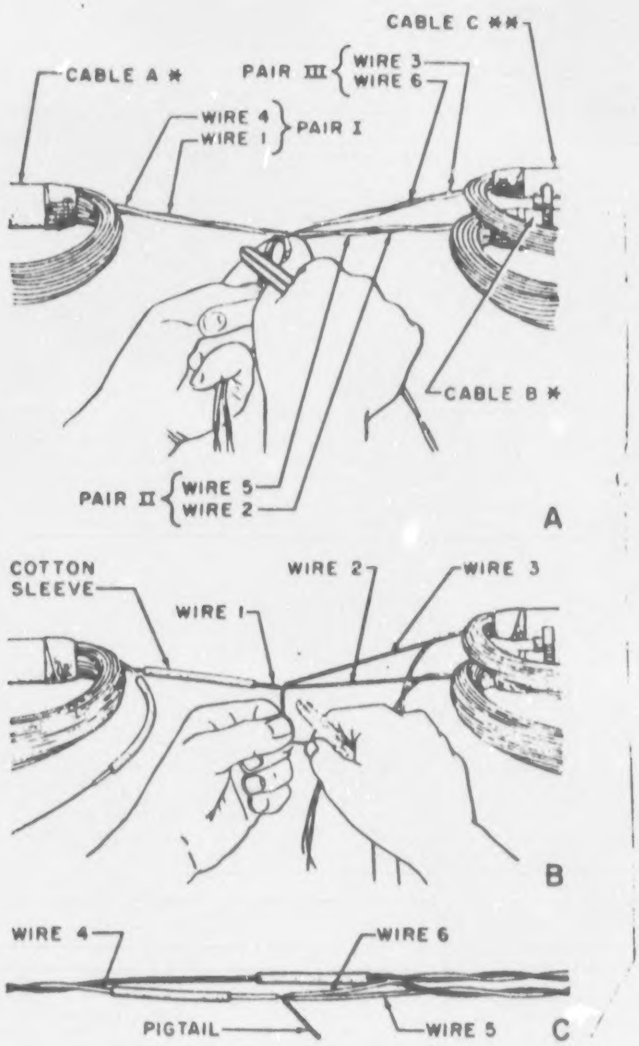
   NOTE: Be careful not to burn a hole in the sheath.

3. Using the same method as step number 9. in the straight splice job sheet, put the cotton sleeve on in the opposite direction that you are going to move the sleeve after the pair of wires are twisted together.

4. Start the bridge splice at the opposite end of the cable from the bridge.


3 IN. SHORTER THAN LEAD SLEEVE
COTTON TAPE
BRANCH CABLE
MAIN CABLE
REMOVE SHEATH OF BRANCH CABLE EVEN WITH SPLICE IN MAIN CABLE.
WIRES BENT BACK READY FOR SPLICING.

WHEN BRANCH CABLE IS SMALLER THAN MAIN CABLE MAKES THE BRIDGE JOINTS IN THE TWO ROWS FURTHEST AWAY FROM THE CROTCH.


CABLE C **
PAIR III
WIRE 3
WIRE 6
CABLE A *
WIRE 4
WIRE 1
PAIR I
CABLE B *
PAIR II
WIRE 5
WIRE 2
A
COTTON SLEEVE
WIRE 2
WIRE 3
WIRE 1
B
WIRE 4
WIRE 6
PIGTAIL
WIRE 5
C

5. When the conductor splicing has been completed boil out the finished splice to eliminate moisture in it.

6. Wrapping the splice.

    a. After the boil out procedure wrap the splice with 4" muslin starting at the center of the splice.

    b. Secure the end of the muslin with a slip knot in the middle.

7. Boiling out the splice for the last time. After the muslin is in place you will boil out the splice once more to be sure that all the moisture is gone.

8. Prepare sheath and sleeve.

    a. Make sure sheath and sleeve surfaces have been cleaned and stearined.

    b. Position sleeve over splice opening and beat sleeve ends tightly around sheath.

    c. Limit the width of the joint by placing paper pasters around the cable and sleeve.

    d. Secure the pan trough below the joint. It is recommended that you place some type of paper (newspaper) in the bottom of the pan to catch the excess solder on. This procedure will enable you to return the cold solder to the heating pot with ease.

    e. Place necessary wiping cloths at a convenient location.

9. Before wiping the bridge end of the splice place a short length of 1/2" cotton tape between the bridge cables. This cotton tape will be used in making the final wipe on the bridge end of the splice.

10. Wiping the sleeve.

    a. Hold catch cloth slightly below the joint.

    b. Pour one ladle of the solder slowly over the sheath and sleeve, moving the ladle in a circular motion at all times.

    NOTE: As you are heating up the joint it is a very good idea to keep pouring the hot solder from the catch cloth back into the ladle. This will help to cool it down.

    c. Raise the catch cloth so that the side edges touch the pasters, while maintaining the center of the catch cloth in the shape of a cup or pocket.

    d. Continue pouring the solder, distributing it over the top and sides of the joint.

    e. Make sure that the joint is well heated.
    DO NOT OVER HEAT.

JOB SHEET 1.2.1.2J (continued)

f. Using the solder in the catch cloth form and pack the joint.

g. Using the wiping cloth make the final three wipes.

h. Using the 1/2" X 18" cotton tape wipe the crotch of the splice once.

11. Testing the splice

a. Pressure test the splice in accordance with TM 11-372-1, paragraph 2-259, pages 2-120 and 2-121.

b. Remove about 18" of the sheath from each end of the splice. This will be used for testing.

c. Test all conductors for tone with the TS-420(B)/U or equivalent test set (76C).

INSTRUCTOR'S INITIALS ______________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.2.1.3J

(TITLE) BUTT SPLICE, LEAD

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete this assigned splice. Before you proceed READ THE ENTIRE JOB SHEET, and if a kit is used be sure you read the instructions that come with the kit.

Once the splice has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of the insulation to the atmosphere.

Satisfactory telephone cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable practices and proficiency in the use of tools and materials.

REFERENCES

Standard Installation Practices Outside Plant Cable Splicing, TM 11-372-1

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Cable cutter
3. Sharpening stone
4. Lead telephone cable, 26 to 101 pair
5. Scotchcast communications kit or equal
6. Cotton sleeves, 52 to 202 each
7. Cotton tape, 1/2"
8. Paper pasters
9. Stearine flux

JOB SHEET 1.2.1.3J (CONTINUED)

10. Paraffin pot

11. Furnace

12. Lead sleeve

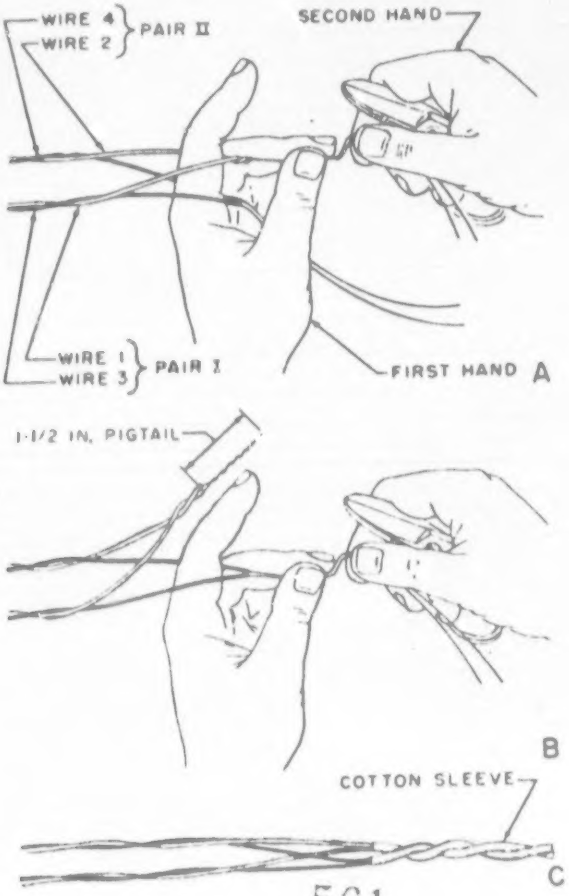
13. 4" wide muslin

14. Solder pot

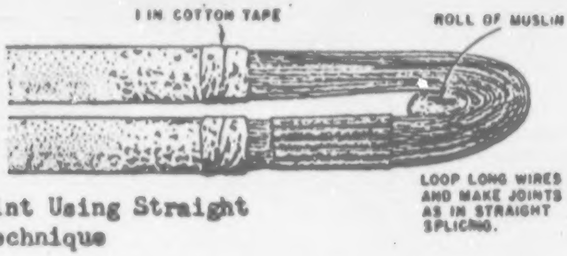
JOB STEPS

1. Prepare lead sleeve. (Do steps 1 through 8 of Job Sheet 1.2.1.1J, Straight Splice, Lead, then proceed with this Job Sheet.)

2. Splice the conductors as per drawing below.


WIRE 4
WIRE 2
PAIR II
SECOND HAND
WIRE 1
WIRE 3
PAIR I
FIRST HAND
A
1-1/2 IN. PIGTAIL
B
COTTON SLEEVE
C

JOB SHEET 1.2.1.3J (CONTINUED)



Butt Joint Using Straight Joint Technique

3. When the conductor splicing has been completed boil out the finished splice to eliminate moisture in it.

4. Wrapping the splice.

   a. After the boil out procedure wrap the splice with 4" muslin starting at the center of the splice.

   b. Secure the end of the muslin with a slip knot in the middle.

5. Boil out the splice for the last time. After the muslin is in place you will boil out the splice once more to be sure that all the moisture is gone.

6. Beat one end of the sleeve completely closed.

7. Position the sleeve on the butt splice over the wedge and beat it down until it is tight.

8. Wiping the sleeve.

   a. Hold the catch cloth slightly below the joint.

   b. Pour one ladle of the solder slowly over the sheath and sleeve, moving the ladle in a circular motion at all times.

   NOTE: As you are heating up the joint it is a very good idea to keep pouring the hot solder from the catch cloth back into the ladle. This will help to cool it down.

   c. Raise the catch cloth so that the side edges touch the pasters, while maintaining the center of the catch cloth in the shape of a cup or pocket.

   d. Continue pouring the solder, distributing it over the top and sides of the joint.

420

JOB SHEET 1.2.1.3J (continued)

e. Make sure that the joint is well heated. DO NOT OVER HEAT.

f. Using the solder in the catch cloth form and pack the joint.

g. Using the wiping cloth make the final three wipes.

h. Wipe the crotch area once with the 1/2" X 18" cotton tape.

9. Testing the splice.

a. Pressure test that splice in accordance with TM 11-372-1, paragraph 2-259, pages 2-120 and 2-121.

b. Remove about 18" of the sheath from each end of the splice. This will be used for testing.

c. Test all conductors for tone with the TS-420(B)/U or equivalent test set (76C).

INSTRUCTOR'S INITIALS ____________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET 1.2.2.1I

(TITLE) COLOR CODES

INTRODUCTION

This information sheet lists the three (3) color codes (Inside, Outside, and Special). These are the standard color codes used by the Navy. These color codes are used for identification of conductor pairs in all telephone cable splicing. There are about 18 different color codes.

REFERENCE

1. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1

2. "Western Electric Company, Telephone Apparatus and Equipment, Catalog, "Section and Cables and Cable Color Codes, AT & T Co. Standard

INFORMATION

1. Even count PIC cable color code identification. Used for inside and outside cables.

Pair No.	Tip	Ring	Group Binder Colors and Numbers
1	White	Blue	1 to 25
2	White	Orange	26 to 50
3	White	Green	51 to 75
4	White	Brown	76 to 100
5	White	Slate	101 to 125
6	Red	Blue	126 to 150
7	Red	Orange	151 to 175
8	Red	Green	175 to 200
9	Red	Brown	201 to 225
10	Red	Slate	226 to 250
11	Black	Blue	251 to 275
12	Black	Orange	276 to 300
13	Black	Green	301 to 325
14	Black	Brown	326 to 350
15	Black	Slate	351 to 375
16	Yellow	Blue	376 to 400
17	Yellow	Orange	401 to 425

INFORMATION SHEET 1.2.2.11 (continued)

Pair No.	Tip	Ring	Group Binder Colors and Numbers
18	Yellow	Green	426 to 450
19	Yellow	Brown	451 to 475
20	Yellow	Slate	476 to 500
21	Violet	Blue	501 to 525
22	Violet	Orange	526 to 550
23	Violet	Green	551 to 575
24	Violet	Brown	576 to 600
25	Violet	Slate	

Cables - 601 pairs or more use multi-unit binders

1 - 600 - White

601 - 1200 - Red

1201 - 1800 - Black

2. Terminating cable textile insulated color code. Inside use only.

Pair No.	Tip	Ring
1	White	Blue
2	White	Orange
3	White	Green
4	White	Brown
5	White	Slate
6	White	Blue-White
7	White	Blue-Orange
8	White	Blue-Green
9	White	Blue-Brown
10	White	Blue-Slate
11	White	Orange-White
12	White	Orange-Green
13	White	Orange-Brown
14	White	Orange-Slate
15	White	Green-White
16	White	Green-Brown
17	White	Green-Slate
18	White	Brown-White
19	White	Brown-Slate
20	White	Slate-White
21-40	Red	
41-60	Black	
61-80	Red-White	

INFORMATION SHEET 1.2.2.1I (continued)

Pair No.	Tip	Ring
81-100	Black-White	
101-120	Red-Black	
121-140	Black-Orange	
141-160	Black-Green	
161-180	Black-Brown	
181-200	Black-Slate	
*201	White	Red
*202	White	Black

***NOTE**: In cables from 6 to 101 pairs, the highest numbered pair has the same colors of insulation as that shown for the pair/designated as 201.

* **NOTE**: In the 152 pair cable, pairs 151 and 152 have colors of insulation corresponding to pairs 201 and 202 respectively.

3. Basically and even-count cable, except each ring and tip, are striped having a narrow strip of the same color as its mate. Inside use only.

Pair No.	Tip	Ring
1	White-Blue	Blue-White
2	White-Orange	Orange-White
3	White-Green	Green-White
4	White-Brown	Brown-White
5	White-Slate	Slate-White
6	Red-Blue	Blue-Red
7	Red-Orange	Orange-Red
8	Red-Green	Green-Red
9	Red-Brown	Brown-Red
10	Red-Slate	Slate-Red
11	Black-Blue	Blue-Black
12	Black-Orange	Orange-Black
13	Black-Green	Green-Black
14	Black-Brown	Brown-Black
15	Black-Slate	Slate-Black
16	Yellow-Blue	Blue-Yellow
17	Yellow-Orange	Orange-Yellow
18	Yellow-Green	Green-Yellow
19	Yellow-Brown	Brown-Yellow
20	Yellow-Slate	Slate-Yellow
21	Violet-Blue	Blue-Violet
22	Violet-Orange	Orange-Violet
23	Violet-Green	Green-Violet
24	Violet-Brown	Brown-Violet
25	Violet-Slate	Slate-Violet

424

INFORMATION SHEET 1.2.2.1I (continued)

4. Special color - coded cables, are similar in construction to the tinned and the enameled conductor type of cables, except that the textile insulation is treated with cellulose acetate lacquer.

567

Colors of Insulation on Conductors

Color Code Identification

In all types of switchboard cable, the outer insulation on the conductors is colored in accordance with a definite color scheme so that they may be easily identified. In the tabulations of switchboard cable on preceding pages, under the heading of Color, the various color combinations of the conductors are identified by the numbers shown.

CHART I

PAIRS

Combination No.	Colors of Insulation*	Paired With**
1c	Blue-1-white	Blue-2-white
2c	Orange-1-white	Orange-2-white
3c	Green-1-white	Green-2-white
4c	Brown-1-white	Brown-2-white
5c	Slate-1-white	Slate-2-white
6c	Blue-1-red	Blue-2-red
7c	Orange-1-red	Orange-2-red
8c	Green-1-red	Green-2-red
9c	Brown-1-red	Brown-2-red
10c	Slate-1-red	Slate-2-red
11c	Blue-1-black	Blue-2-black
12c	Orange-1-black	Orange-2-black
13c	Green-1-black	Green-2-black
14c	Brown-1-black	Brown-2-black
15c	Slate-1-black	Slate-2-black
16c	Blue-1-yellow	Blue-2-yellow
17c	Orange-1-yellow	Orange-2-yellow
18c	Green-1-yellow	Green-2-yellow
19c	Brown-1-yellow	Brown-2-yellow
20c	Slate-1-yellow	Slate-2-yellow

*1 Single dot marking. For example, Blue-1-white is a blue wire with single white dots spaced approximately 11/16-inch apart.

**2 Double dot marking. For example, Orange-2-red is an orange wire with two red dots spaced approximately 3/16-inch apart. The distance between pairs of dots is approximately 11/16-inch.

SPARE PAIRS

Combination No.	Colors of Insulation*	Paired With**
1c	White-1-black	White-2-black
2c	White-1-yellow	White-2-yellow
3c	Red-1-white	Red-2-white
4c	Red-1-yellow	Red-2-yellow
5c	Red-1-black	Red-2-black

SINGLES

Combination No.	Colors of Insulation***	Combination No.	Colors of Insulation***
1c	Blue-3-white	11c	Blue-3-black
2c	Orange-3-white	12c	Orange-3-black
3c	Green-3-white	13c	Green-3-black
4c	Brown-3-white	14c	Brown-3-black
5c	Slate-3-white	15c	Slate-3-black
6c	Blue-3-red	16c	Blue-3-yellow
7c	Orange-3-red	17c	Orange-3-yellow
8c	Green-3-red	18c	Green-3-yellow
9c	Brown-3-red	19c	Brown-3-yellow
10c	Slate-2-red	20c	Slate-3-yellow

SPARE SINGLES

Combination No.	Colors of Insulation***
1c	White-3-black
2c	White-3-yellow
3c	Red-3-white
4c	Red-3-yellow
5c	Red-3-black

*1 Single dot marking. For example, Blue-1-white is a blue wire with single white dots spaced approximately 11/16-inch apart.

**2 Double dot marking. For example, Orange-2-red is an orange wire with two red dots spaced approximately 3/16-inch apart. The distance between pairs of dots is approximately 11/16-inch.

***3 Dash marking. For example, Green-3-white is a green wire with white dashes, approximately 5/16-inch long, spaced approximately 11/16-inch apart.

CHART II

PAIRS

Combination No.	Colors of Insulation	Paired With
1	Blue	White
2	Orange	White
3	Green	White
4	Brown	White
5	Slate	White
6	Blue-white	White
7	Blue-orange	White
8	Blue-green	White
9	Blue-brown	White
10	Blue-slate	White
11	Orange-white	White
12	Orange-green	White
13	Orange-brown	White
14	Orange-slate	White
15	Green-white	White

426

CABLES

Colors of Insulation on Conductors

CHART II (Continued)

PAIRS

Combination No.	Colors of Insulation	Paired With
16	Green-brown	White
17	Green-slate	White
18	Brown-white	White
19	Brown-slate	White
20	Slate-white	White
21	Blue	Red
22	Orange	Red
23	Green	Red
24	Brown	Red
25	Slate	Red
26	Blue-white	Red
27	Blue-orange	Red
28	Blue-green	Red
29	Blue-brown	Red
30	Blue-slate	Red
31	Orange-white	Red
32	Orange-green	Red
33	Orange-brown	Red
34	Orange-slate	Red
35	Green-white	Red
36	Green-brown	Red
37	Green-slate	Red
38	Brown-white	Red
39	Brown-slate	Red
40	Slate-white	Red
41	Blue	Black
42	Orange	Black
43	Green	Black
44	Brown	Black
45	Slate	Black
46	Blue-white	Black
47	Blue-orange	Black
48	Blue-green	Black
49	Blue-brown	Black
50	Blue-slate	Black
51	Orange-white	Black
52	Orange-green	Black
53	Orange-brown	Black
54	Orange-slate	Black
55	Green-white	Black
56	Green-brown	Black
57	Green-slate	Black
58	Brown-white	Black
59	Brown-slate	Black
60	Slate-white	Black
61	Blue	Red-white
62	Orange	Red-white
63	Green	Red-white
64	Brown	Red-white
65	Slate	Red-white
66	Blue-white	Red-white
67	Blue-orange	Red-white
68	Blue-green	Red-white
69	Blue-brown	Red-white

PAIRS

Combination No.	Colors of Insulation	Paired With
70	Blue-slate	Red-white
71	Orange-white	Red-white
72	Orange-green	Red-white
73	Orange-brown	Red-white
74	Orange-slate	Red-white
75	Green-white	Red-white
76	Green-brown	Red-white
77	Green-slate	Red-white
78	Brown-white	Red-white
79	Brown-slate	Red-white
80	Slate-white	Red-white
81	Blue	Black-white
82	Orange	Black-white
83	Green	Black-white
84	Brown	Black-white
85	Slate	Black-white
86	Blue-white	Black-white
87	Blue-orange	Black-white
88	Blue-green	Black-white
89	Blue-brown	Black-white
90	Blue-slate	Black-white
91	Orange-white	Black-white
92	Orange-green	Black-white
93	Orange-brown	Black-white
94	Orange-slate	Black-white
95	Green-white	Black-white
96	Green-brown	Black-white
97	Green-slate	Black-white
98	Brown-white	Black-white
99	Brown-slate	Black-white
100	Slate-white	Black-white
101	Blue	Red-black
102	Orange	Red-black
103	Green	Red-black
104	Brown	Red-black
105	Slate	Red-black
106	Blue-white	Red-black
107	Blue-orange	Red-black
108	Blue-green	Red-black
109	Blue-brown	Red-black
110	Blue-slate	Red-black
111	Orange-white	Red-black
112	Orange-green	Red-black
113	Orange-brown	Red-black
114	Orange-slate	Red-black
115	Green-white	Red-black
116	Green-brown	Red-black
117	Green-slate	Red-black
118	Brown-white	Red-black
119	Brown-slate	Red-black
120	Slate-white	Red-black
121	Red-blue	White
122	Red-orange	White
123	Red-green	White
124	Red-brown	White
125	Red-slate	White

CABLES

Colors of Insulation on Conductors

CHART II (Continued)

PAIRS

Combination No.	Colors of Insulation	Paired With
126	Red-blue-white	White
127	Red-blue-orange	White
128	Red-blue-green	White
129	Red-blue-brown	White
130	Red-blue-slate	White
131	Red-orange-white	White
132	Red-orange-green	White
133	Red-orange-brown	White
134	Red-orange-slate	White
135	Red-green-white	White
136	Red-green-brown	White
137	Red-green-slate	White
138	Red-brown-white	White
139	Red-brown-slate	White
140	Red-slate-white	White
141	Red-blue	Red
142	Red-orange	Red
143	Red-green	Red
144	Red-brown	Red
145	Red-slate	Red
146	Red-blue-white	Red
147	Red-blue-orange	Red
148	Red-blue-green	Red
149	Red-blue-brown	Red
150	Red-blue-slate	Red
151	Red-orange-white	Red
152	Red-orange-green	Red
153	Red-orange-brown	Red
154	Red-orange-slate	Red
155	Red-green-white	Red
156	Red-green-brown	Red
157	Red-green-slate	Red
158	Red-brown-white	Red
159	Red-brown-slate	Red
160	Red-slate-white	Red
161	Black-blue	Red
162	Black-orange	Red
163	Black-green	Red
164	Black-brown	Red
165	Black-slate	Red
166	Black-blue-white	Red
167	Black-blue-orange	Red
168	Black-blue-green	Red
169	Black-blue-brown	Red
170	Black-blue-slate	Red
171	Black-orange-white	Red
172	Black-orange-green	Red
173	Black-orange-brown	Red
174	Black-orange-slate	Red
175	Black-green-white	Red
176	Black-green-brown	Red
177	Black-green-slate	Red
178	Black-brown-white	Red
179	Black-brown-slate	Red
180	Black-slate-white	Red

PAIRS

Combination No.	Colors of insulation	Paired With
181	Blue	Blue-Novelty red white
182	Orange	Orange-Novelty red white
183	Green	Green-Novelty red white
184	Brown	Brown-Novelty red white
185	Slate	Slate-Novelty red white
186	Blue-white	Blue-white-Novelty red white
187	Blue-orange	Blue-orange-Novelty red white
188	Blue-green	Blue-green-Novelty red white
189	Blue-brown	Blue-brown-Novelty red white
190	Blue-slate	Blue-slate-Novelty red white
191	Orange-white	Orange-white-Novelty red white
192	Orange-green	Orange-green-Novelty red white
193	Orange-brown	Orange-brown-Novelty red white
194	Orange-slate	Orange-slate-Novelty red white
195	Green-white	Green-white-Novelty red white
196	Green-brown	Green-brown-Novelty red white
197	Green-slate	Green-slate-Novelty red white
198	Brown-white	Brown-white-Novelty red white
199	Brown-slate	Brown-slate-Novelty red white
200	Slate-white	Slate-white-Novelty red white

Note: Color listed as "Novelty red white" consists of one ply of red yarn twisted together with one ply of white yarn to form a single thread.

CHART III
SINGLES

Combination No.	Colors of Insulation	Combination No.	Colors of Insulation
1	Red-blue	31	Black-orange-white
2	Red-orange	32	Black-orange-green
3	Red-green	33	Black-orange-brown
4	Red-brown	34	Black-orange-slate
5	Red-slate	35	Black-green-white
6	Red-blue-white	36	Black-green-brown
7	Red-blue-orange	37	Black-green-slate
8	Red-blue-green	38	Black-brown-white
9	Red-blue-brown	39	Black-brown-slate
10	Red-blue-slate	40	Black-slate-white
11	Red-orange-white	41	Red-black-blue
12	Red-orange-green	42	Red-black-orange
13	Red-orange-brown	43	Red-black-green
14	Red-orange-slate	44	Red-black-brown
15	Red-green-white	45	Red-black-slate
16	Red-green-brown	46	Red-black-blue-white
17	Red-green-slate	47	Red-black-blue-orange
18	Red-brown-white	48	Red-black-blue-green
19	Red-brown-slate	49	Red-black-blue-brown
20	Red-slate-white	50	Red-black-blue-slate
21	Black-blue	51	Red-black-orange-white
22	Black-orange	52	Red-black-orange-green
23	Black-green	53	Red-black-orange-brown
24	Black-brown	54	Red-black-orange-slate
25	Black-slate	55	Red-black-green-white
26	Black-blue-white	56	Red-black-green-brown
27	Black-blue-orange	57	Red-black-green-slate
28	Black-blue-green	58	Red-black-brown-white
29	Black-blue-brown	59	Red-black-brown-slate
30	Black-blue-slate	60	Red-black-slate-white

CABLES

Colors of Insulation on Conductors

CHART IV

PAIRS WITH BRAIDED COTTON CONDUCTORS

Combination No.	Colors of Insulation	Paired With
1b	Blue	Blue-red
2b	Orange	Orange-red
3b	Green	Green-red
4b	Brown	Brown-red
5b	Slate	Slate-red
6b	Blue-white	Blue-white-red
7b	Blue-orange	Blue-orange-red
8b	Blue-green	Blue-green-red
9b	Blue-brown	Blue-brown-red
10b	Blue-slate	Blue-slate-red
11b	Orange-white	Orange-white-red
12b	Orange-green	Orange-green-red
13b	Orange-brown	Orange-brown-red
14b	Orange-slate	Orange-slate-red
15b	Green-white	Green-white-red
16b	Green-brown	Green-brown-red
17b	Green-slate	Green-slate-red
18b	Brown-white	Brown-white-red
19b	Brown-slate	Brown-slate-red
20b	Slate-white	Slate-white-red

SPARE PAIRS

1b	White	Red

TRIPLES WITH BRAIDED COTTON CONDUCTORS

1b	Blue	Blue-red and white
2b	Orange	Orange-red and white
3b	Green	Green-red and white
4b	Brown	Brown-red and white
5b	Slate	Slate-red and white
6b	Blue-white	Blue-white-red and white
7b	Blue-orange	Blue-orange-red and white
8b	Blue-green	Blue-green-red and white
9b	Blue-brown	Blue-brown-red and white
10b	Blue-slate	Blue-slate-red and white

CHART V

QUADS

Quad No.		First Pair	Second Pair	
1	Blue	Blue-red	Blue-Novelty black white	Blue-Novelty red white
2	Orange	Orange-red	Orange-Novelty black white	Orange-Novelty red white
3	Green	Green-red	Green-Novelty black white	Green-Novelty red white
4	Brown	Brown-red	Brown-Novelty black white	Brown-Novelty red white
5	Slate	Slate-red	Slate-Novelty black white	Slate-Novelty red white
6	Blue-white	Blue-white-red	Blue-white-Novelty black white	Blue-white-Novelty red white
7	Blue-orange	Blue-orange-red	Blue-orange-Novelty black white	Blue-orange-Novelty red white
8	Blue-green	Blue-green-red	Blue-green-Novelty black white	Blue-green-Novelty red white
9	Blue-brown	Blue-brown-red	Blue-brown-Novelty black white	Blue-brown-Novelty red white
10	Blue-slate	Blue-slate-red	Blue-slate-Novelty black white	Blue-slate-Novelty red white
11	Orange-white	Orange-white-red	Orange-white-Novelty black white	Orange-white-Novelty red white
12	Orange-green	Orange-green-red	Orange-green-Novelty black white	Orange-green-Novelty red white
13	Orange-brown	Orange-brown-red	Orange-brown-Novelty black white	Orange-brown-Novelty red white
14	Orange-slate	Orange-slate-red	Orange-slate-Novelty black white	Orange-slate-Novelty red white
15	Green-white-red	Green-white-red	Green-white-Novelty black white	Green-white-Novelty red white
16	Green-brown	Green-brown-red	Green-brown-Novelty black white	Green-brown-Novelty red white
17	Green-slate	Green-slate-red	Green-slate-Novelty black white	Green-slate-Novelty red white
18	Brown-white	Brown-white-red	Brown-white-Novelty black white	Brown-white-Novelty red white
19	Brown-slate	Brown-slate-red	Brown-slate-Novelty black white	Brown-slate-Novelty red white
20	Slate-white	Slate-white-red	Slate-white-Novelty black white	Slate-white-Novelty red white
Spare	Red	Red-white	Black	Black-red

Note: Color listed as "Novelty black white" or "Novelty red white" consists of one ply of black or red yarn twisted together with one ply of white yarn to form a single thread.

PAIRED INTERCOM CABLE

I. DESCRIPTION

A. Conductors are solid or stranded tinned copper, 22 & 18 AWG.

B. Conductors paired with short lay for balance and easy identification.

C. Pairs cabled with open binder necessary.

D. Jacket is a free striping chrome gray PVC.

E. Insulation is color coded PVC as follows :

COLOR COMBINATION

PAIR NO.	FIRST COLOR	PAIRED WITH
1.	Black	Red
2.	Black	White
3.	Black	Green
4.	Black	Blue
5.	Black	Brown
6.	Black	Yellow
7.	Black	Orange
8.	Red	Green
9.	Red	White
10.	Red	Blue
11.	Red	Yellow
12.	Red	Brown
13.	Red	Orange
14.	Green	Blue
15.	Green	White
16.	Green	Brown
17.	Green	Orange
18.	Green	Yellow
19.	White	Blue
20.	White	Brown
21.	White	Orange
22.	White	Yellow
23.	Blue	Brown
24.	Blue	Orange
25.	Blue	Yellow

430

PAIR NO.	FIRST COLOR	PAIRED WITH
26.	Brown	Orange
27.	Brown	Yellow
28.	Purple	Red
29.	Purple	White
30.	Purple	Green
31.	Purple	Blue
32.	Purple	Brown
33.	Purple	Yellow
34.	Purple	Orange
35.	Purple	Slate
36.	Purple	Black
37.	Slate	Red
38.	Slate	White
39.	Slate	Green
40.	Slate	Blue
41.	Slate	Brown
42.	Slate	Yellow
43.	Slate	Orange
44.	Slate	Black
45.	White/Black	Red
46.	White/Black	Green
47.	White/Black	Blue
48.	White/Black	Brown
49.	White/Black	Yellow
50.	White/Black	Orange
51.	White/Black	Purple

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.2.2.1J

(TITLE) STRAIGHT SPLICE, PLASTIC

INTRODUCTION

The purpose of this job sheet is to guide you in the practical application of the 1A1 and the 1B1 Ready Access splice and all the parts that make up the ready-access kits.

It is important that you read the entire job sheet and any instructions that may be included with the kit before you begin the splice.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

REFERENCES

1. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1
2. Standard Installation Practices Outside Plant Cable Pressurization, TM 11-372-1
3. Construction Electrician 3 & 2, NAVPERS 10636-G
4. Cable Splicing Handbook 2, 1972. AT&T Company

EQUIPMENT AND MATERIALS

1. Cable splicer's tool box
2. Cable, plastic, telephone, 100 pair, #22 AWG (10' per student)
3. 1B1 Ready-Access Kit
4. "B" Connectors 19 to 26 AWG
5. Scotchlock Connectors
    a. UY 19 to 26 AWG
    b. UR 19 to 26 AWG

JOB SHEET 1.2.2.1J (continued)

6. Pick-A-Bon Splice connector

7. Tapes

    a. B paper tape

    b. Rubber tape

    c. Vinyl tape

8. Telephone Test Set, TS-420(B)/U

JOB STEPS

Perform Job Steps as outlined in Chapter 7, TM 11-372-5.

INSTRUCTOR'S INITIALS ____________

433

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.2.2.2J

(TITLE) BRIDGE SPLICE, PLASTIC

INTRODUCTION

The purpose of this job sheet is to guide you in the practical application of the 1A1 and the 1B1 Ready Access splice and all the parts that make up the ready-access kits.

It is important that you read the entire job sheet and any instructions that may be included with the kit before you begin the splice.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

REFERENCES

1. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1
2. Standard Installation Practices Outside Plant Cable Pressurization, TM 11-372-5
3. Cable Splicing Handbook 2, 1972, AT&T Company
4. Construction Electrician 3 & 2, NAVPERS 10636-G

EQUIPMENT AND MATERIALS

1. Cable splicer's tool box
2. Cable, plastic, telephone, 100 pair, #22 AWG (6' per student)
3. 1B1 Ready-Access Kit
4. "B" Connectors 19 to 26 AWG
5. Scotchlock Connector - UG 19 to 26 AWG
6. Pick-A-Bon Splice connector

434

JOB SHEET 1.2.2.2J (continued)

7. Tapes

   a. B paper tape

   b. Rubber tape

   c. Vinyl tape

8. Telephone Test Set, TS-420(B)/U

JOB STEPS

Perform Job Steps as outlined in Chapter 7, TM 11-372-5

INSTRUCTOR'S INITIALS ____________

577

435

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.2.2.3J

(TITLE) BUTT SPLICE, PLASTIC

INTRODUCTION

The purpose of this job sheet is to guide you in the practical application of the 1A1 and the 1B1 Ready Access splice and all the parts that make up the ready-access kits.

It is important that you read the entire job sheet and any instructions that may be included with the kit before you begin the splice.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

REFERENCES

1. Splicing Cable (Outside Plant) Standard Installation Practices, TM 11-372-1
2. Standard Installation Practices Outside Plant Cable Pressurization, TM 11-372-5
3. Construction Electrician 3 & 2, NAVPERS 10636-G
4. Cable Splicing Handbook 2, 1972, AT&T Company

EQUIPMENT AND MATERIALS

1. Cable splicer's tool box
2. Cable, plastic, telephone, 100 pair, #22 AWG (4' per student)
3. 1A1 Ready-Access kit
4. Incapslating kit
5. "B" Connectors 19 to 26 AWG
6. Scotchlock Connectors
    a. UY 19 to 26 AWG
    b. UR 19 to 26 AWG

JOB SHEET 1.2.2.3J (continued)

7. Pick-A-Bon Splice connector

8. Tapes

    a. B paper tape

    b. Rubber tape

    c. Vinyl tape

9. Telephone Test Set, TS-420(B)/U

JOB STEPS

Perform Job Steps as outlined in Chapter 7, TM 11-372-5.

INSTRUCTOR'S INITIALS ______________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET 1.2.3.11

(TITLE) DESICCANT

INTRODUCTION

Desiccant is a powder that is used to dry out (remove moisture from) cable ends, sheath openings of continuous cable, and splicing material. In its type of drying action, a desiccant may be considered to be a drawing agent. Although not quite as effective as paraffin, desiccant is frequently used because of its comparatively wide margin of convenience and safety. To insure satisfactory results when desiccating, personnel must fully observe the required precautions.

REFERENCE

1. Splicing Cable (outside Plant) Standard Installation Practices, TM 11-372-1

2. Construction Electrician 3 & 2, NAVPERS 10636-G

INFORMATION

1. Precautions

   a. When working with plastic-sheathed cable, make sure that you use the correct amount of desiccant. An excessive amount of desiccant may cause the somewhat porous plastic sheath to absorb moisture from the surrounding atmosphere.

   b. Do not permit desiccant to enter the ends of coaxials. Do not place desiccant inside the muslin wrappings around coaxials.

   c. Do not use desiccant in duct splices of large cables. Space limitations usually do not permit placement of a desiccant quantity sufficient to dry the splice.

   d. If there is a small amount of moisture in paper or pulp insulation, it may be quite difficult to break and strip the insulation when forming conductor joints. This condition can generally be corrected by gently rubbing a small quantity of desiccant on the insulation to be broken and stripped.

   e. Keep all desiccant containers tightly closed so that the desiccant does not absorb atmospheric moisture and become unusable.

If a container of desiccant is only partially used during one application, use the retained desiccant within one (1) week and make sure that the container is kept tightly closed when not in use.

f. Discard any container of desiccant that may have absorbed moisture.

g. Coat hands with a light application of petrolatum or splicing oil to relieve the excessive dryness resulting from the handling of a desiccant.

h. Handle desiccant carefully, so that the air inhaled will be as free as possible of its particles.

i. Although the particles of desiccant are harmless, wear goggles to keep particles out of eyes.

2. Desiccant Container

a. Desiccant is supplied in 40- and 650-gram, screw top cans. Since the can cap holds 5 grams of desiccant when level full, it may be used to measure small quantities of desiccant. When the 650-gram can is used on small splices, use an empty 40- or 160-gram can as a convenient means of measurement.

3. Drawing Power of Desiccant

a. Desiccant acts as a drawing agent and produces an absorbent action.

(1) The rapidity with which desiccant can dry a splice depends upon the amount of moisture present and upon several other factors. These additional factors may be stated as follows:

(a) Small splices usually dry more quickly than large splices.

(b) Tight bending of splices tends to slow the drying rate.

(c) Paraffined sleeve insulations lose moisture more quickly than unparaffined sleeve insulations.

(2) Some desiccated splices attain high insulation resistance between conductors quickly, while others require days or even weeks to acquire the same measure of resistance. Typical variations in the time required for desiccated splices to acquire high insulation resistance may be illustrated as follows:

(a) Insulation resistance measurements were made on splices of an 1818-pair underground cable between individual

100-pair groups and all the other wires and the cable sheath.

(b) The fastest drying splice was located in a dry atmosphere. In this splice, all 100-pair groups tested above 1000 megohms immediately after completion of sleeve wiping.

(c) The slowest drying splice was located in a deep, highly humid manhole. In this splice the different 100-pair groups tested 6 to 250 megohms immediately after completion of sleeve wiping. All 100-pair groups tested 1000 megohms in 21 days.

(d) In the test of the completely spliced cable, the different 100-pair groups tested 14 to 1000 megohms 18 hours after completion of sleeve wiping; all 100-pair groups tested 1000 megohms after 30 days.

4. Desiccant Quantity

a. The quantity of desiccant required for a splice depends upon the the type of conductor insulation and the number of pairs entering the splice. To determine the quantity of desiccant required, refer to table 3-II.

(1) If quadded cable is used, consider that each quad is two pairs and determine the quantity accordingly.

(2) When all conductors in a cable are cut, use as the total, the number of pairs in all cables entering the splice.

(3) In a straight splice without a change of cable size, consider the total number of pairs to be twice the actual number of pairs in the cable.

(4) In a bridge splice, use as the total number of pairs, the sum of the feeder pairs on each side of the splice plus the pairs in the branch cable.

(5) At test openings, which are made when locating cable trouble, and at splices where all the conductors are not cut, -- for example, splices involving distribution terminals--consider that all the conductors were cut. Use only one-half the determined desiccant quantity in this case, but do not use less than 20 grams.

(6) When closing an existing open splice, determine the desiccant quantity as though a new splice were involved.

(7) For splices containing extra quantities of muslin--for example, splices involving coaxial or shielded-layer cable--use 20 to 40 grams of desiccant in addition to the quantity determined from the table. Gage the exact quantity of additional dessiccant in direct proportion to the cable size.

(8) If the splice contains a string-type capacitor, use 5 extra grams of desiccant. If the splice contains a spool-type capacitor or a spool-type loading coil, use 10 or 15 extra grams of desiccant. If the splice contains a spool-type loading coil, use 10 or 15 extra grams of desiccant.

(9) In a temporarily closed sheath opening or splice, use the desiccant quantity that would be required if the opening or splice were being permanently closed. When work is resumed, be sure to remove and discard the desiccant.

5. Examples

a. The following examples illustrate the use of Table 3-II.

(1) When splicing a 1212-pair, 24-gage cable to a 1212-pair, 22 gage, textile-insulated cable, use 1200 grams of desiccant:

Under 1212 pairs, 22 gage read:	200 grams
Under 1212 pairs, textile, read:	1000 grams
Total =	1200 grams

(2) When splicing a 16-pair terminal into a 202-pair, 26-gage cable with all pairs cut, use 80 grams of desiccant:

Under 202 pairs, 26 gage, read:	35 grams
Under 202 pairs, 26 gage, read:	35 grams
Under 16 pairs, terminal tap, read:	10 grams
Total =	80 grams

(3) When making a bridge splice consisting of a 404-pair, 24-gage cable that is diminished to a 303-pair, 24-gage cable with a 202-pair, 24 gage branch cable, use 155 grams of desiccant:

Under 404 pairs, 24 gage, read:	70 grams
Under 303 pairs, 24 gage, read:	50 grams
Under 202 pairs, 24 gage, read:	35 grams
Total =	155 grams

TABLE 3-II. DESICCANT QUANTITIES

Number of pairs	Type of Cable: 19-, 22-, and finer-gage distribution; 22- and finger-gage submarine (desiccant quantity---grams)	Type of Cable: 19-, and heavier-gage trunk or submarine; any gage of textile (desiccant quantity---grams)
6	10*	10*
11	10*	10*
16	10*	15*
26	10*	20
51	10*	40
76	15*	65
101	20	85
152	25	125
202	35	170
303	50	250
404	70	340
455	75	380
606	100	500
909	150	750
1212	200	1000
1515	300	1500
2121	350	1750

*Use 20 grams for a cleared end or cap splice. For butt splice, add 50 percent to quantities specified.

442.

6. Desiccating Procedures

   a. Cable. Apply the following procedure regardless of whether the exposed cable is continuous or non-continuous:

      (1) Envelop the exposed core section with a single piece of muslin which, in relation to the exposed core section, is 2 inches longer and overlaps a minimum of 1 inch at the top.

      (2) Open the overlap slightly.

      (3) Spread the conductors with your fingers.

      (4) Sprinkle the desiccant down on the conductors, taking care to insure ample distribution of the desiccant near the sheath ends.

      (5) Close the muslin and wrap with two layers of unboiled muslin bandage. This completes the procedure.

   b. Splicing Materials. In desiccating splicing materials, such as muslin, cotton sleeves, and cotton tape, proceed as follows:

      (1) Place the material into an airtight container.

      (2) Place 20 to 40 grams of desiccant into the container.

      (3) Keep the materials in the container for a minimum of 12 hours prior to use.

7. Use of Splicing Oil and Desiccant in Removing Pulp Insulation

   a. To facilitate the removal of insulation during splicing, prepare pulp-insulated conductors as follows:

      (1) Paint a bunch of 100 to 200 conductors with a light coat of splicing oil. Apply the oil to the section of insulation to be removed from each conductor. This section will normally consist of a 3 or 4-inch tail located at the free end of each conductor.

      (2) Make sure that the oil thoroughly saturates the section to be removed.

      (3) Sprinkle desiccant over the conductors, so that the oil not absorbed by the pulp is dried up.

      (4) Rub the pairs between the palms of your hands gently, and then shake out the desiccant. The conductors are now ready for splicing.

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.2.3.1J

(TITLE) JOINING PLASTIC AND LEAD SHEATHED TELEPHONE CABLE - STRAIGHT SPLICE

INTRODUCTION:

This job sheet is designed for your use and it provides the necessary information that is needed to complete the assigned splice. Before you proceed READ THE ENTIRE JOB SHEET, and any instructions that may be included with the kit.

Once the splice has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of the insulation to the atmosphere.

Satisfactory telephone cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable practices and proficiency in the use of tools and materials.

REFERENCES

Construction Electrician 3 & 2, NAVPERS 10636-G

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Cable cutters
3. Sharpening stone
4. Lead telephone cable, 26 to 51 pair (6' per student)
5. Plastic telephone cable, 26 to 51 pair (6' per student)
6. Plastic filled sleeves 52 to 102 each (3/32 per student)
7. 1/2" cotton tape (1 roll per student)
8. Paraffin pot
9. Paraffin
10. Furnace
11. Lead sleeve (1 per student)

444

JOB SHEET 1.2.3.1J (continued)

12. Tape, plastic (1 roll per student)
13. Tape, rubber (2 rolls per student)
14. Tape, 4", adhesive-backed aluminum (1 roll per student)
15. Tape, 2", adhesive-backed aluminum (1 toll per student)
16. Tape, Scotch electrical shielding #24 or equivalent (1 roll per student)
17. Solder
18. Copper, Solder
19. Paste, solder

JOB STEPS

1. Prepare cables
   a. Arrange the cables into the desired final position
      (1) Remove any end cap or protection
      (2) Avoid severe bending
      (3) Allow sufficient overlap of ends, about 18".
   b. Determine the length and size of lead sleeve, using the following table:

SIZE OF CABLE	(IN INCHES) LENGTH OF SHEATH OPENING	(IN INCHES) SIZE LEAD SLEEVE
11 to 51 pair	11-1/2"	1-1/2 x 15
76 to 101 pair	13-1/2"	1-3/4 x 17
152 pair	13-1/2"	2 x 17

   c. After you have established the center line, mark each cable for the proper opening.
   d. On the lead sheath cable make an additional mark at 4".
   e. On the plastic sheathed cable make an additional mark at 7".

NOTE: Prepare the plastic cable first.

7. Plastic cable preparation. (Polyethylene (Pe) sheathed cable) - Straight splice.
   a. Remove the outer Pe sheath at the appropriate mark.

   b. Remove the shielding. CAUTION: Do not cut your fingers or nick the conductors.

   c. When applicable remove inner Pe sheath.

   d. Remove core wrapper.

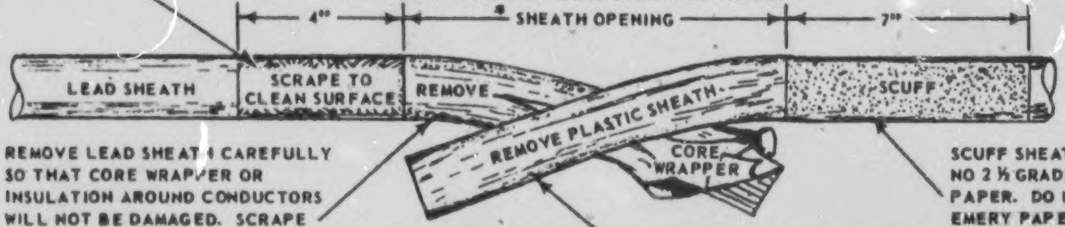
   e. Remove another 1/2" of outer Pe sheath.

   f. Solder 48" of Scotch #24 electrical shielding tape to the copper sheath.

   g. Scuff seven (7) inches. See figure below.

STRAIGHT SPLICE

SPLICING PLASTIC INSULATED - PLASTIC SHEATHED CABLES TO PAPER INSULATED - LEAD SHEATHED CABLES



MARK LOCATION OF SPLICE OPENING AND DISTANCE ON EACH SIDE

REMOVE LEAD SHEATH CAREFULLY SO THAT CORE WRAPPER OR INSULATION AROUND CONDUCTORS WILL NOT BE DAMAGED. SCRAPE SHEATH TO PRESENT A CLEAN SURFACE FOR JOINING. SECURE CORE WRAPPER WITH TAPE AT END OF LEAD SHEATH AND REMOVE EXCESS WRAPPER.

REMOVE SHEATH CAREFULLY SO THAT METAL SHIELD CORE WRAPPER OR INSULATION AROUND CONDUCTORS WILL NOT BE DAMAGED. TURN BACK SHIELD AND REMOVE CORE WRAPPER.

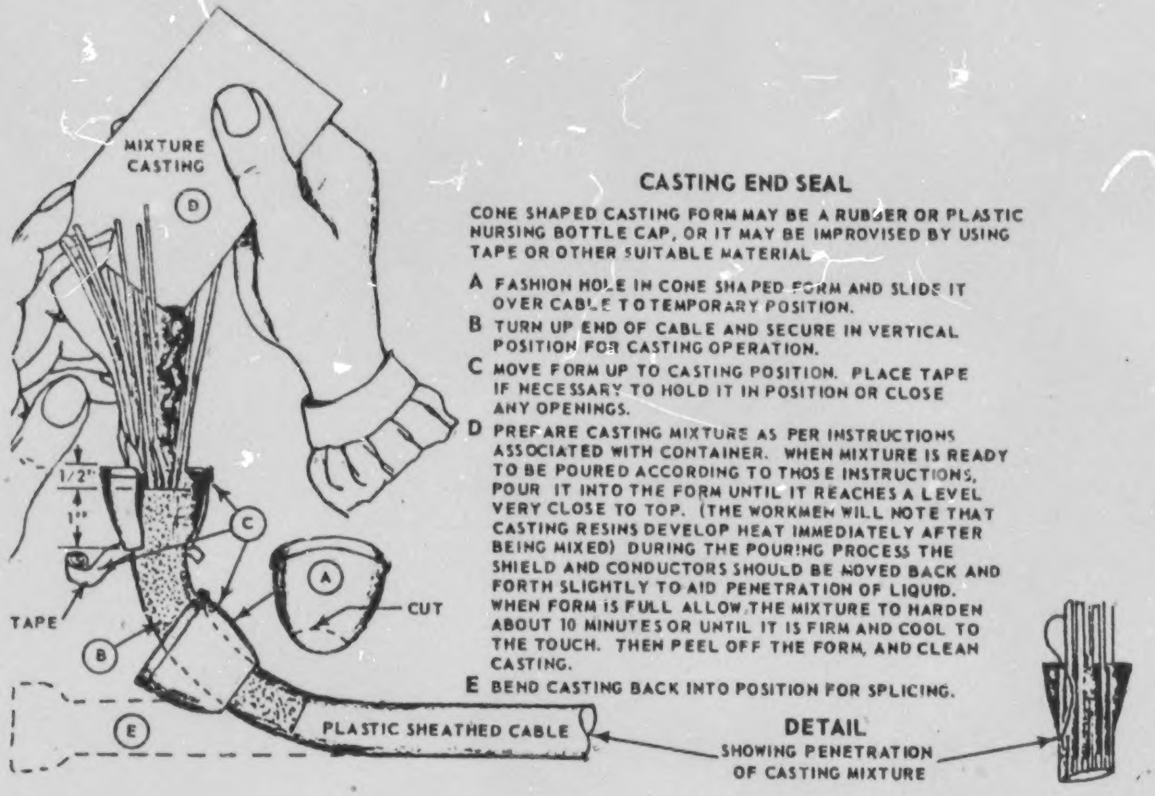
SCUFF SHEATH WITH NO 2 ½ GRADE SAND PAPER. DO NOT USE EMERY PAPER OR CLOTH.

   h. Prepare a cone-shaped casting form. (One may be made from a cone-shaped paper cup or something similar.)

   i. Insure the large diameter of the form is not larger than the inside diameter of the lead sleeve being used.

   j. Fashion a hole in the cone-shaped form and slide it over the cable to a temporary position about 4" from the Pe sheath end.

k. Turn up end of cable and secure in a vertical position for casting operation. See figure below.



CASTING END SEAL

CONE SHAPED CASTING FORM MAY BE A RUBBER OR PLASTIC NURSING BOTTLE CAP, OR IT MAY BE IMPROVISED BY USING TAPE OR OTHER SUITABLE MATERIAL.

A FASHION HOLE IN CONE SHAPED FORM AND SLIDE IT OVER CABLE TO TEMPORARY POSITION.
B TURN UP END OF CABLE AND SECURE IN VERTICAL POSITION FOR CASTING OPERATION.
C MOVE FORM UP TO CASTING POSITION. PLACE TAPE IF NECESSARY TO HOLD IT IN POSITION OR CLOSE ANY OPENINGS.
D PREPARE CASTING MIXTURE AS PER INSTRUCTIONS ASSOCIATED WITH CONTAINER. WHEN MIXTURE IS READY TO BE POURED ACCORDING TO THOSE INSTRUCTIONS, POUR IT INTO THE FORM UNTIL IT REACHES A LEVEL VERY CLOSE TO TOP. (THE WORKMEN WILL NOTE THAT CASTING RESINS DEVELOP HEAT IMMEDIATELY AFTER BEING MIXED) DURING THE POURING PROCESS THE SHIELD AND CONDUCTORS SHOULD BE MOVED BACK AND FORTH SLIGHTLY TO AID PENETRATION OF LIQUID. WHEN FORM IS FULL ALLOW THE MIXTURE TO HARDEN ABOUT 10 MINUTES OR UNTIL IT IS FIRM AND COOL TO THE TOUCH. THEN PEEL OFF THE FORM, AND CLEAN CASTING.
E BEND CASTING BACK INTO POSITION FOR SPLICING.

l. Move form up to casting position and place plastic tape, if necessary to hold it in position or to close any openings. The rim of the mold will be about 1/2" above the Pe jacket of the inner Pe jacket or shielding.

m. Prepare casting mixture as per instructions associated with container.

n. When mixture is ready according to the instructions, pour it into the form until it reaches a level very close to the top.

CAUTION: Some casting resins will develop heat immediately after being mixed, so read the instructions very carefully.

o. During the pouring process the shielding tape and conductors should be moved back and forth slightly to aid the penetration of the liquid.

p. When the form is full allow the mixture to harden or until it is firm and cool to the touch.

q. Then peel off the form and clean the casting.

r. Bend the cable with the casting back into position for splicing.

Sleeve preparation

a. Clean one end of the sleeve 7" from the end and stearine it

b. Clean the other end 2" and stearine it

c. Place the lead sleeve on the lead cable of your splice back out of the way

3. Lead sheath preparation

a. Ring the lead sheath. CAUTION: Do not ring too deep to nick conductors.

b. Scrape and clean the lead sheathed cable thoroughly with the shave hook back to the mark that you made in step 1.d.

c. Immediately after cleaning the sheath, coat it thoroughly with stearine.

d. Apply two layers of paper pasters at each end of the cleaned cable

e. Tin the cable

f. After the sheath has cooled it is time to remove that portion of the sheathed cable in front of the tinned area.

g. Be sure the bell is in position and apply the choker.

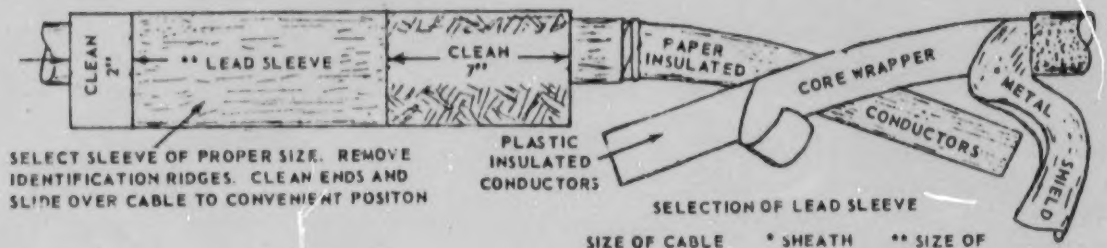
h. Carefully spread the wires so that they can be boiled out

i. Prepare the paraffin

j. Set catch pan in such a way so that it will be easy to pour the hot liquid back into the pot.

k. Starting about 6 to 8" from the butt of the cable you will pour hot paraffin over the sheath and work it toward the exposed conductors until all conductors are thoroughly soaked.

1. Return the excess liquid to the pot.

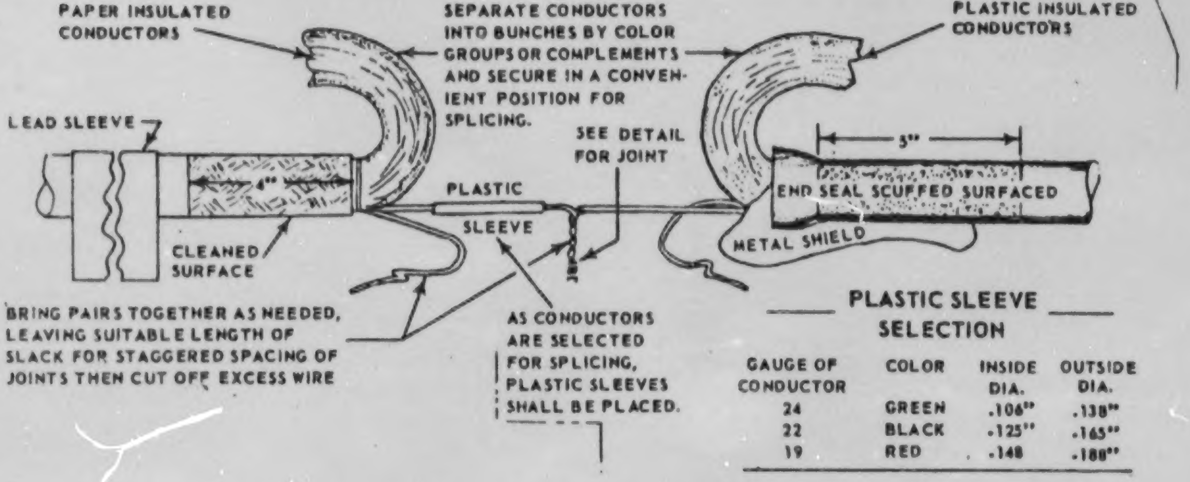

CLEAN 2"
** LEAD SLEEVE
CLEAN 7"
PAPER INSULATED
CORE WRAPPER
CONDUCTORS
METAL SHIELD
PLASTIC INSULATED CONDUCTORS
SELECT SLEEVE OF PROPER SIZE. REMOVE IDENTIFICATION RIDGES. CLEAN ENDS AND SLIDE OVER CABLE TO CONVENIENT POSITON

SELECTION OF LEAD SLEEVE

SIZE OF CABLE IN 22 GAUGE	* SHEATH OPENING	** SIZE OF SLEEVE
11 TO 51 PR	11 ½"	1 ½" X 15"
76 TO 101 PR	13 ½"	1 ¾" X 17"
152 PR	13 ½"	2" X 17"

4. Splice preparation.

   a. Separate conductors into bunches by color groups or complements. Secure them in a convenient position for splicing, leaving suitable length for staggered splicing. See figure below.


PAPER INSULATED CONDUCTORS
SEPARATE CONDUCTORS INTO BUNCHES BY COLOR GROUPS OR COMPLEMENTS AND SECURE IN A CONVENIENT POSITION FOR SPLICING.
PLASTIC INSULATED CONDUCTORS
LEAD SLEEVE
4"
SEE DETAIL FOR JOINT
5"
END SEAL SCUFFED SURFACED
METAL SHIELD
PLASTIC SLEEVE
CLEANED SURFACE
BRING PAIRS TOGETHER AS NEEDED, LEAVING SUITABLE LENGTH OF SLACK FOR STAGGERED SPACING OF JOINTS THEN CUT OFF EXCESS WIRE
AS CONDUCTORS ARE SELECTED FOR SPLICING, PLASTIC SLEEVES SHALL BE PLACED.

PLASTIC SLEEVE SELECTION

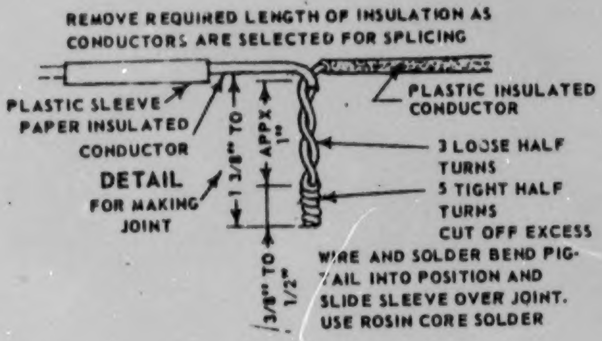
GAUGE OF CONDUCTOR	COLOR	INSIDE DIA.	OUTSIDE DIA.
24	GREEN	.106"	.138"
22	BLACK	.125"	.165"
19	RED	.148	.188"

   b. As pairs are selected for splicing, place a plastic sleeve over one conductor in the opposite direction of which you will lay the conductor after the splice is made.

      NOTE: Skip the above step when using filled sleeves, B-connectors, or other types of connectors other than plastic sleeves.

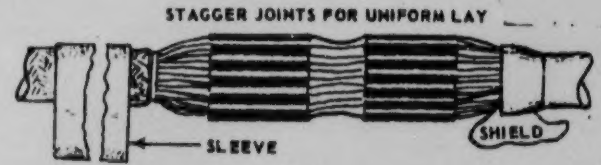
c. Remove required length of insulation from the conductors.

d. Twist the individual, skinned conductors together. Make joint 1-3/8" to 1-3/4". Be sure to stagger joints for a uniform lay, starting with three loose half-turns (about 1"), then finishing with five tight half-turns (about 3/8" to 1/2").


REMOVE REQUIRED LENGTH OF INSULATION AS CONDUCTORS ARE SELECTED FOR SPLICING
PLASTIC SLEEVE
PAPER INSULATED CONDUCTOR
DETAIL FOR MAKING JOINT
1 3/8" TO
APPX 1"
3/8" TO 1/2"
PLASTIC INSULATED CONDUCTOR
3 LOOSE HALF TURNS
5 TIGHT HALF TURNS
CUT OFF EXCESS WIRE AND SOLDER BEND PIGTAIL INTO POSITION AND SLIDE SLEEVE OVER JOINT. USE ROSIN CORE SOLDER

e. Cut off excess wire.

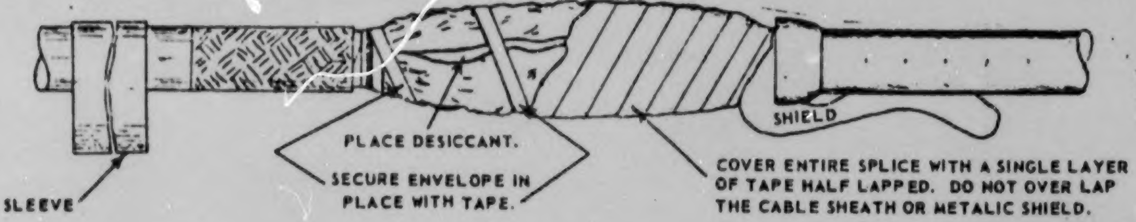
f. Bend pigtail into place and slide previously placed sleeve over the joint.


STAGGER JOINTS FOR UNIFORM LAY
SLEEVE
SHIELD

g. After all the conductors have been spliced and placed in the proper layup, wrap the body of the splice with plastic envelope cut from a sheet of polyethylene or equivalent material, leaving a slot at the top to put in the desiccant. See figure below.

WRAP SLICED CONDUCTORS WITH AN ENVELOPE MADE OF POLYETHYLENE. DESICCANT SHALL BE PLACED IN ENVELOPE AS FOLLOWS:

SIZES OF CABLES	WEIGHT IN GRAMS
51 PAIR AND SMALLER	20
76 AND 101 PAIRS	40
152 AND 202 PAIRS	70
LARGER THAN 202 PAIRS	30 PER EACH 100 PAIRS

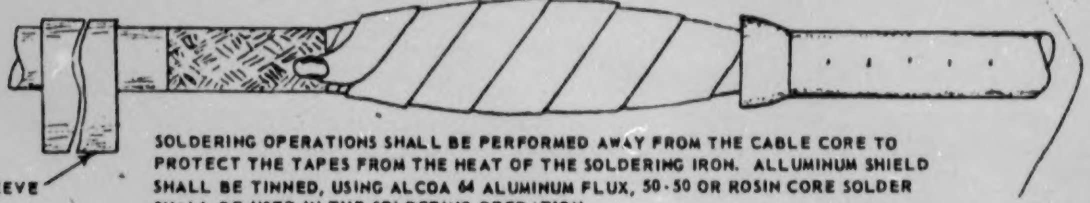

SHIELD
PLACE DESICCANT.
SECURE ENVELOPE IN PLACE WITH TAPE.
COVER ENTIRE SPLICE WITH A SINGLE LAYER OF TAPE HALF LAPPED. DO NOT OVER LAP THE CABLE SHEATH OR METALIC SHIELD.
SLEEVE

h. After the envelope has been made put in the proper amount of desiccant using the figure above as a guide.

5. Wrapping the splice.

a. Cover the whole splice with a single layer of half-lapped vinal tape. Do not overlap cable sheath or metallic shield.

b. Wrap the splice with Scotch #24 copper tape, extending it onto the lead sheathed cable. Solder the end of the shielding tape to the lead sheathed cable at a point of the overlap. See figure below.

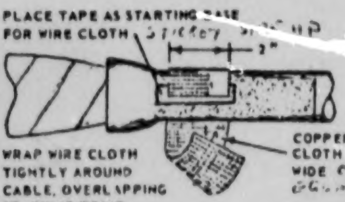


TO INSURE CONTINUITY OF SHIELD, REWRAP METAL SHIELD TAPE AND SOLDER IT TO THE LEAD SHEATH. IF SHIELD IS NOT LONG ENOUGH SOLDER ON AN ADDITIONAL PIECE OF SHIELD.

SOLDERING OPERATIONS SHALL BE PERFORMED AWAY FROM THE CABLE CORE TO PROTECT THE TAPES FROM THE HEAT OF THE SOLDERING IRON. ALLUMINUM SHIELD SHALL BE TINNED, USING ALCOA 64 ALUMINUM FLUX, 50-50 OR ROSIN CORE SOLDER SHALL BE USED IN THE SOLDERING OPERATION.

6. Lead sleeve placement.

a. Place a strip of tape on the plastic sheathed cable lengthwise about 2-1/4" from the base of the casted end seal, starting at the base of the cast and going down 2". Secure the strip of tape, starting the edge of wire tape with the edge of the plastic tape. Wrap the copper tape tightly around the cable, overlapping the starting point about 1". See figure below.

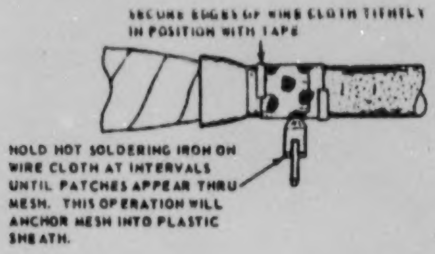


PLACE TAPE AS STARTING BASE FOR WIRE CLOTH

WRAP WIRE CLOTH TIGHTLY AROUND CABLE, OVERLAPPING STARTING POINT ABOUT 1 INCH

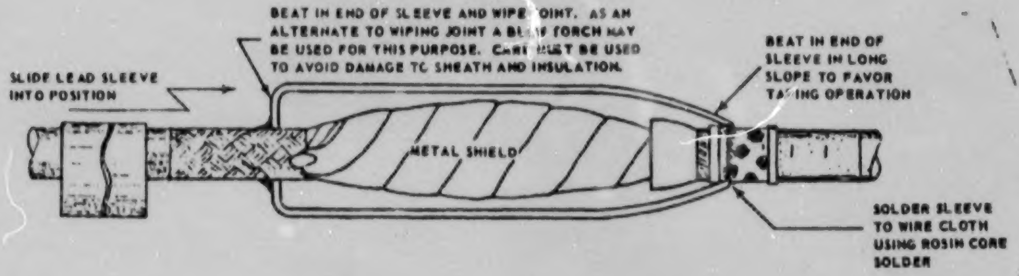
COPPER WIRE CLOTH 2" WIDE

b. Secure the edges of the wire tape with the vinyl tape tabs that are sticking out from under the copper tape. See figure below.


SECURE EDGES OF WIRE CLOTH TIGHTLY IN POSITION WITH TAPE
HOLD HOT SOLDERING IRON ON WIRE CLOTH AT INTERVALS UNTIL PATCHES APPEAR THRU MESH. THIS OPERATION WILL ANCHOR MESH INTO PLASTIC SHEATH.

c. Using a hot iron press it firmly against the wire tape at numerous points around the sheath until dark patches appear through the mesh. See figure below.

d. Place the lead sleeve over the splice, overlapping the lead-sheathed cable about 1-1/2", and overlapping the wire tape on the plastic-sheathed cable about 1". See figure below.


BEAT IN END OF SLEEVE AND WIPE JOINT. AS AN ALTERNATE TO WIPING JOINT A BLOW TORCH MAY BE USED FOR THIS PURPOSE. CARE MUST BE USED TO AVOID DAMAGE TO SHEATH AND INSULATION.
SLIDE LEAD SLEEVE INTO POSITION
METAL SHIELD
BEAT IN END OF SLEEVE IN LONG SLOPE TO FAVOR TAPING OPERATION
SOLDER SLEEVE TO WIRE CLOTH USING ROSIN CORE SOLDER

e. Beat in the end of the lead sleeve on the lead-sheathed cable side of the splice and wipe it in the usual manner. See figure above.

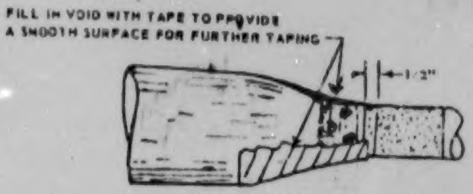
f. On the plastic sheathed cable shape the end of the sleeve to the copper wire in a gradually tapering slope. See figure above.

g. Solder the sleeve to the copper tape. See figure above.

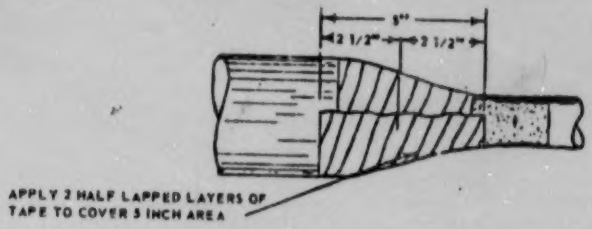
7. Tapping the Joint.

452

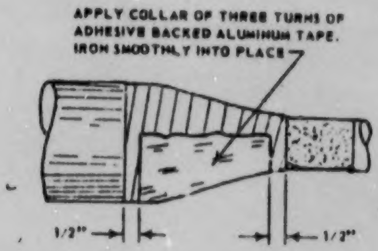
a. Fill in the voids between the plastic sheathed cable and the lead sleeve with rubber tape. See figure below.


FILL IN VOID WITH TAPE TO PROVIDE
A SMOOTH SURFACE FOR FURTHER TAPING
1/2"

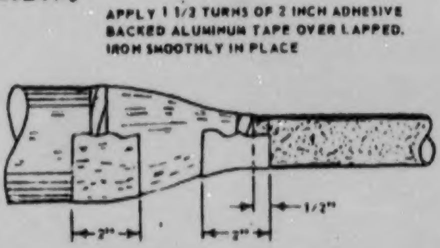
b. Apply 2 half-lapped layers of tape, extending 2-1/2" on each side of the point where the lead sleeve is joined to the wire tape. See figure below.


5"
2 1/2"
2 1/2"
APPLY 2 HALF LAPPED LAYERS OF
TAPE TO COVER 5 INCH AREA

c. Apply a collar of three turns of 4" adhesive-backed aluminum tape and iron smoothly into place with a cable dresser. See figure below.


APPLY COLLAR OF THREE TURNS OF
ADHESIVE BACKED ALUMINUM TAPE.
IRON SMOOTHLY INTO PLACE
1/2"
1/2"

d. Apply 1-1/2 turns of 2" adhesive-backed aluminum tape at each end of the first collar, overlapping previously placed aluminum tape about 1/2". See figure below.


APPLY 1 1/2 TURNS OF 2 INCH ADHESIVE
BACKED ALUMINUM TAPE OVER LAPPED.
IRON SMOOTHLY IN PLACE
1/2"
2"
2"

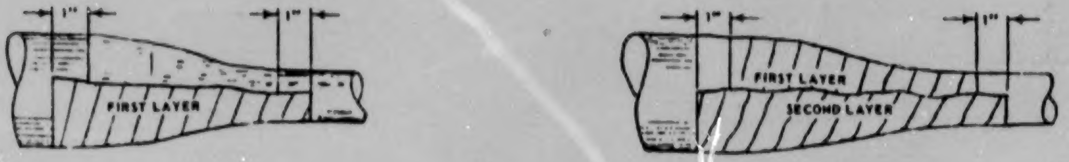
e. Iron smoothly with a cable dresser.

f. Apply 2 half-lapped layers of vinyl tape.

  (1) Start the first layer on the lead sleeve 1" beyond the aluminum tape.

  (2) Start the second layer on the lead sleeve 1" beyond the end of the previous layer and extend it 1" beyond the end of the first layer. See figure below.

APPLY 2 HALF LAPPED LAYERS OF PLASTIC TAPE.



FIRST LAYER: START ON LEAD SLEEVE AND EXTEND ON TO PLASTIC SHEATH

SECOND LAYER: START ON LEAD SLEEVE AND EXTEND ON TO PLASTIC SHEATH. THIS COMPLETES THE SPLICE.

INSTRUCTOR'S INITIALS: ___________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET 1.3.1.1I

(TITLE) TYPES OF POWER CABLE

INTRODUCTION:

The proper selection and application of power cable splicing materials are often thought to be an extremely difficult task. To be a successful cable splicer, you must first know the various types of cable conductors, insulations, and sheaths.

Actually, this task is not as difficult as it may originally appear, since a limited number of cables can be used to fulfill practically all industrial applications.

This Information Sheet is designed to provide you with added information used in identifying cables by type conductor, insulation, sheath, voltage rating and their applications.

REFERENCES:

1. Underground Systems Reference Book, 1957, Chapter 2, Pages 1 through 40, Edison Electric Institute.
2. Fundamentals of Utility Wire, by William S. Laughlin, Staff Engineer, Pamcor, Inc.
3. General Electric Wire and Cable Selection and Technical Data Book, Sections CM-642, CM-644, and CM-650.

INFORMATION

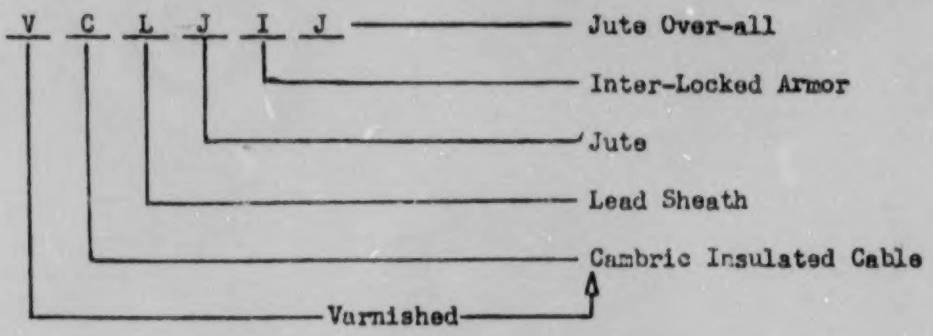
1. For convenience in the identification of cable, the following abbreviations and symbols are used.

   a. Abbreviations

(1) American Wire Gage	A.W.G.
(2) Circular Mils	C.M.
(3) 1,000 Circular Mils	M.C.M.
(4) Birmingham Wire Gage	B.W.G.

(5)	Copper	CU
(6)	Aluminum	AAC or AL
(7)	Aluminum Conductor Steel Reinforced	ACSR
b.	Insulation	Abbreviations
(1)	Asbestos	A.
(2)	Paper	P.
(3)	Polyethylene	POLY/PE
(4)	Cross-linked Polyethylene	X.L.P. or X.L.P.E. or C.L.P.
(5)	Rubber	R.
(6)	Varnish-Cambric	V.C.
(7)	Varnish-Dacron Glass	V.D.G.
(8)	Polytetrafluoroethylene	T.F.E.
(9)	Fluorinated-Ethylene-Propylene	F.E.P.
(10)	Voltage-Stabilized Polyethylene	V.S.P.
(11)	Cross-linked Thermo-setting Polyethylene	X.H.H.W.
c.	Sheath, Jacket or Finish	Abbreviations
(1)	Asbestos	A.
(2)	Flat-band Metallic Armor	F.
(3)	Interlocked Metallic Armor	I.
(4)	Jute-Asphalted (Non-metallic Armor)	J.
(5)	Lead Sheath	L.
(6)	Rubber Sheath	R.
(7)	Poly-Vinyl-Chloride	P.V.C.
(8)	Wire Armor (Round-Wire Armor)	W.

d. EXAMPLE:


V C L J I J
Jute Over-all
Inter-Locked Armor
Jute
Lead Sheath
Cambric Insulated Cable
Varnished

2. The most common shapes of conductors used is shown and described below. The two (2) most common types of conductors are copper and aluminum.

a. Solid Conductor - is used on cable of smaller sizes and is recommended for sizes No. 6 AWG and smaller. However, they can be obtained in all sizes up to a No. 4/0 (0000) A.W.G.

EXAMPLE: "O" is used to show a solid wire

b. Concentric Round (Stranded).

(1) Standard strand (Class-B) has a total of 19 strands.

(2) Class - C stranding has 37 strands.

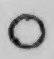
(3) Each strand ordinarily is of the same A.W.G.

(4) There is either one or three strands in the core of the conductor.

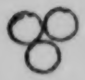
(5) Successive layers have a right-hand spiral.

(6) Examples of both one (1) or three (3) core stranded cables are shown below:

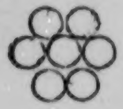
(See next page)



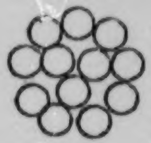
SOLID WIRE



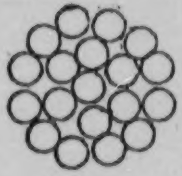
3-WIRE



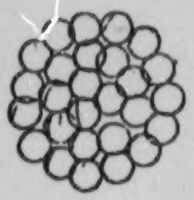
7-WIRE



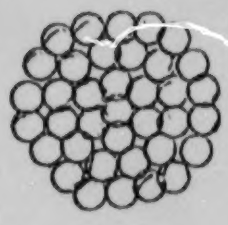
12-WIRE



19-WIRE
Standard
Class "B"



27-WIRE



37-Strand cable - Class "C"

NOTE: If you can divide the number of strnads evenly by three (3) there are three (3) strands in the core of the conductor.

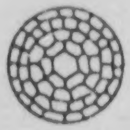
c. Compact round (compact strand).

(1) Smaller diameter than concentric round conductor of the same A.W.G.

(2) Formed by rolling each layer before next layer is applied eliminating spaces between strands.

(3) Less flexible than concentric round conductors.

(4) This type of stranding offers some material advantages because of the saving it affords in weight and outside diameter of the finished cable. This means that lighter and less costly suspension structures may be used in aerial work, and smaller ducts in underground work. This conductor can be made up in round or segmental construction. It offers almost all the advantages of the solid conductor, plus a much greater degree of flexibility, which is necessary on the larger cables.



COMPACT ROUND

d. Compact sector.

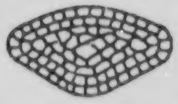
(1) Used in three (3) conductor cables.

(2) Furnished only with impregnated-paper and varnished-cambric insulation type cables.

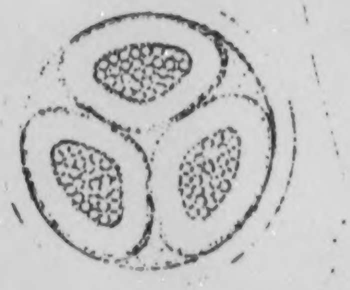
(3) A compact sector conductor is a stranded conductor in which the cross-section is shaped like a sector of a circle.

(4) The main advantages of this construction are low reactance (lower voltage drop) and smaller cable diameter than the corresponding concentric stranded cables, thus, less weight due to the amount of lead sheath required and lower cost.

(5) This conductor is stiffer, harder to splice and over-all more expensive than concentric stranded conductors.



COMPACT SECTOR CONDUCTOR



COMPACT SECTOR CONDUCTOR CABLE

e. Annular.

(1) An annular conductor offers a means of reducing the skin effect on conductors 1,000 MCM and above.

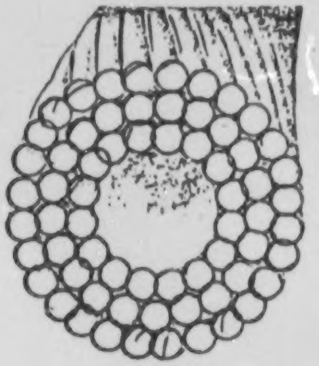
(2) Greater current carrying capacity because of increased radiating surface.

(3) This conductor is made up of a treated-jute rope core around which bare-copper wires are stranded helically.

(4) Usually three (3) layers of strands. Each layer laid in the opposite direction to the preceding layer.

(5) Usually insulated with varnished-cambric.

(6) Commonly used for generator leads and similar applications.



ANNULAR CONDUCTOR

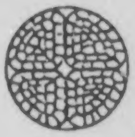
f. Segmental.

(1) The segmental conductor is another means employed to reduce skin effect. It permits construction of a smaller cable than an annular conductor does.

(2) It consists of three (3) or four (4) segments separated by means of paper tape stranded together and operated in parallel. This gives the effect of a transposition of strands from the center to the outside of the conductor and thereby reduces the skin effect which lowers A.C. resistance.

(3) Only used in single conductor (1/C) cables where high current carrying capacity and minimum diameter must be combined.

460



SEGMENTAL CONDUCTOR

3. Insulation - Power cables can be divided into two classifications with respect to the insulation. These are the extruded type and the laminated or taped type.

   a. The extruded types of insulation are applied by forcing through a die to be pressed and shaped around the conductor to the required thickness. These types are bases and mixtures of the following:

      (1) Rubber.

      (2) Silicone.

      (3) Polyethylene.

      (4) Poly Vinyl-chloride.

      (5) Cross-Linked Polyethylene.

   b. The laminated types of insulation are applied as a tape. The number of layers required would be determined by the type of insulation and cable rating. These type tapes are:

      (1) Varnished Cambric.

      (2) Varnished Dacron Glass.

      (3) Polyester Glass.

      (4) Paper-Impregnated Types.

603

4. Sheath, Protective Covering or Finish.

   a. Finishes may be classified.

      (1) First as to the material employed:

         (a) Metallic

         (b) Non-metallic

      (2) Second as to their function:

         (a) Moisture-resistant

         (b) Weather-resistant

         (c) Flame-resistant

         (d) Corona-resistant

         (e) Wear and abrasion-resistant

         (f) Tension-resistant

         (g) Corrosion-resistant

         (h) Miscellaneous

   b. Metallic finishes are:

      (1) Pure lead sheath

      (2) Reinforced lead sheath

      (3) Flat-band or tape armor

      (4) Inter-locked armor

      (5) Round-wire armor

      (6) Basket-weave armor (braid)

   c. Non-Metallic finishes are:

      (1) Neoprene

      (2) Poly-vinyl-chloride

      (3) Polyethylene

INFORMATION SHEET 1.3.1.11 (continued)

(4) Hose-jacket

(5) Hypalon

(6) Nylon

(7) Flame and moisture-resistant (weather-resistant) braid

(8) Flame-resistant finishes

(9) Asbestos, glass or rayon braids

The attached pages are put out by the Minnesota Mining and Manufacturing Company (3M Co.). They list these cable types of code letters and numbers. If you need splicing instructions all you need to do is locate the cable nearest to what you have. Then give a full description by conductor insulation and sheath plus their code number and letter.

Give this information to one of their Sales Representatives to obtain splicing instructions.

QUESTIONS

1. What is the insulation and sheath abbreviation for paper-insulated lead sheath cable with a polyethylene jacket?

   ANS: ____.

2. What type of cable does the abbreviation R-R stand for?

   ANS: ____.

3. How many strands are in the Class B, #4/0 A.W.G. wire using the single wire core?

   ANS: ____.

4. Give two advantages the compact round has over the concentric round conductor cable?

   ANS: ____

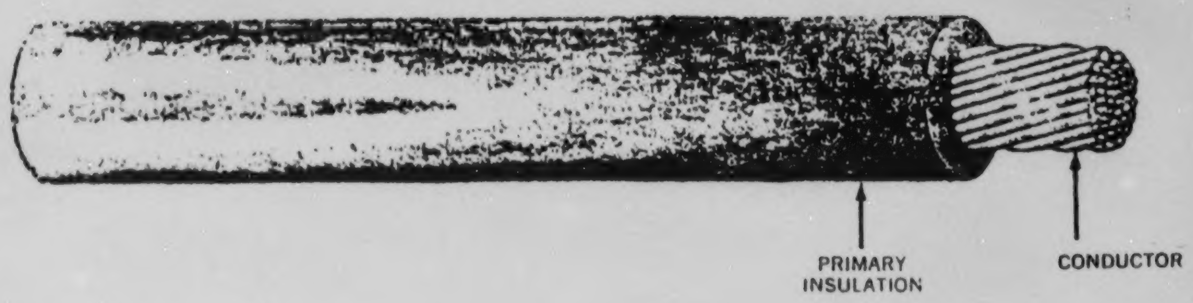
   ____.

5. Name three extruded type insulations.

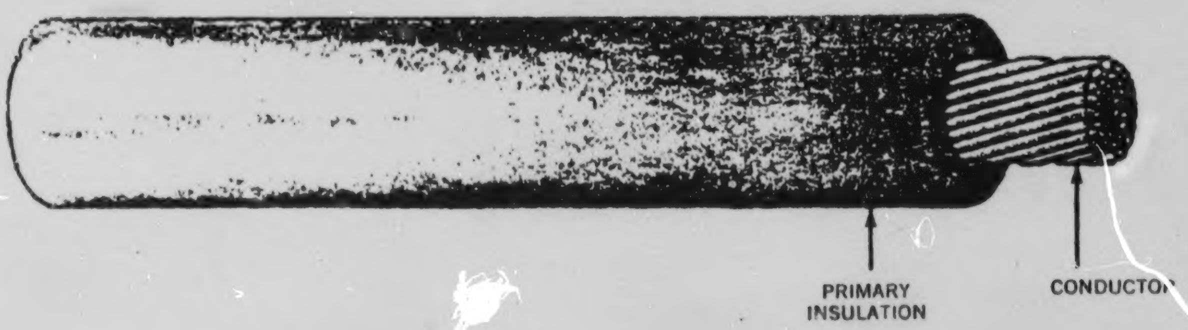
ANS: ____

____.

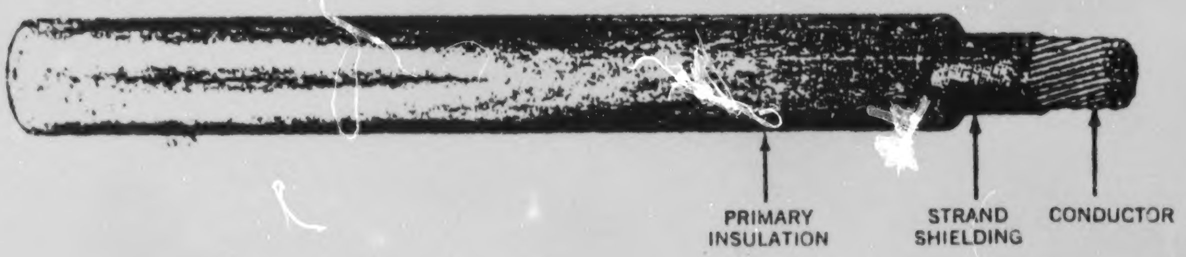
CABLE TYPE 1A


PRIMARY INSULATION
CONDUCTOR

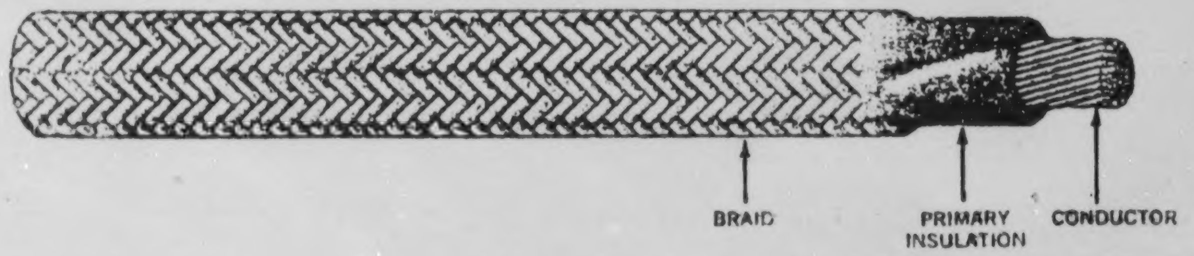
CABLE TYPE 1A (HEAVY DUTY)


PRIMARY INSULATION
CONDUCTOR

CABLE TYPE 2A

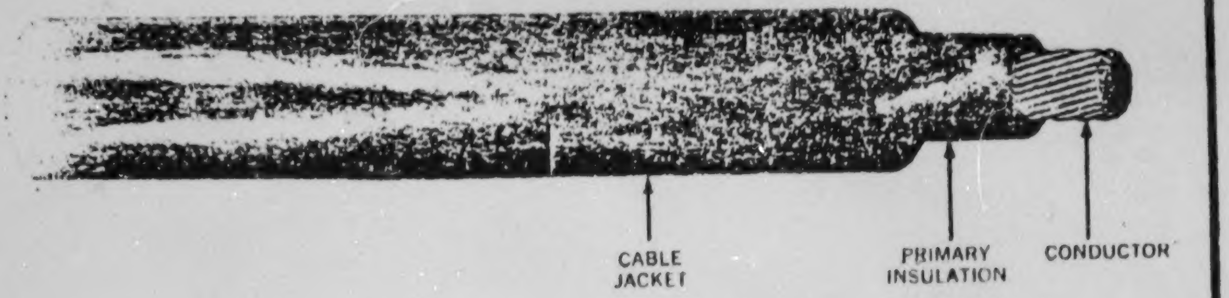

PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

CABLE TYPE 2B

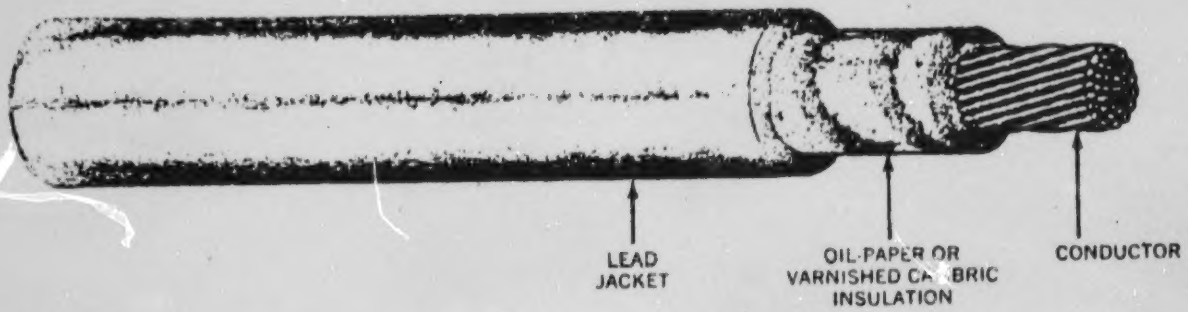

BRAID
PRIMARY INSULATION
CONDUCTOR

464

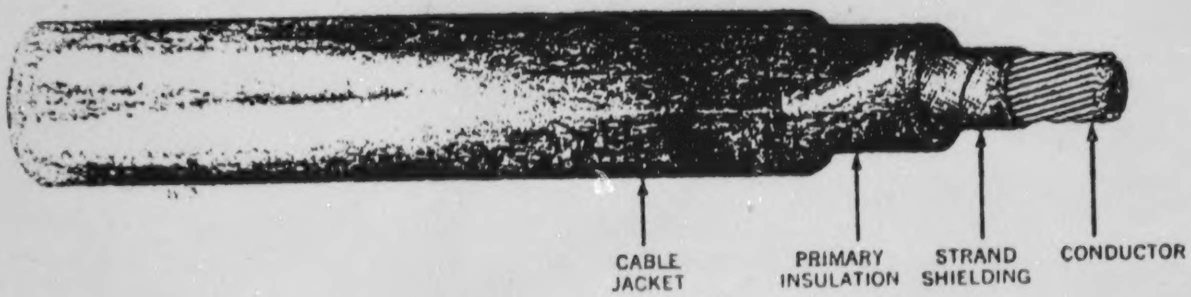
CABLE TYPE 2C


CABLE JACKET
PRIMARY INSULATION
CONDUCTOR

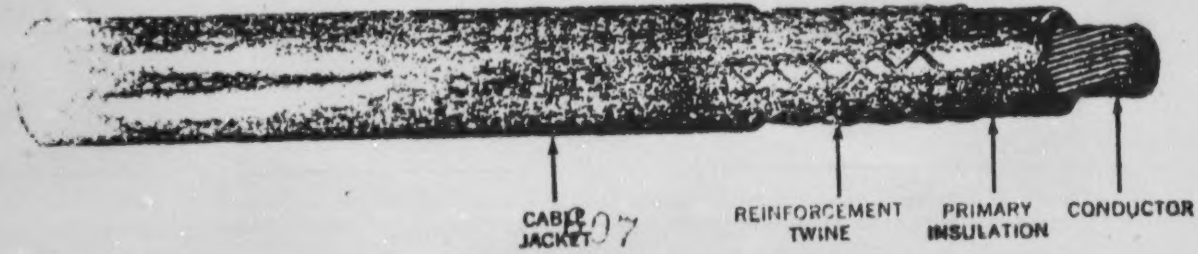
CABLE TYPE 2D


LEAD JACKET
OIL-PAPER OR VARNISHED CAMBRIC INSULATION
CONDUCTOR

CABLE TYPE 3A


CABLE JACKET
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

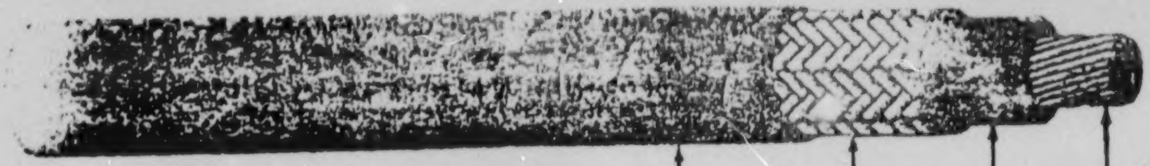
CABLE TYPE 3B


CABLE JACKET
REINFORCEMENT TWINE
PRIMARY INSULATION
CONDUCTOR

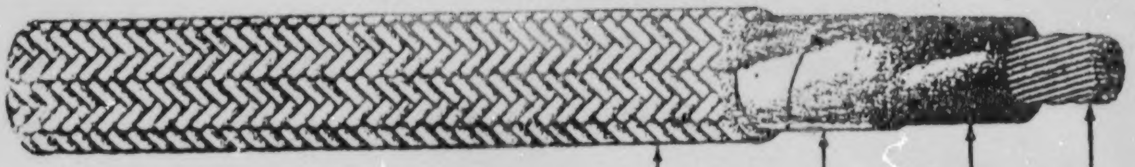
807

11.

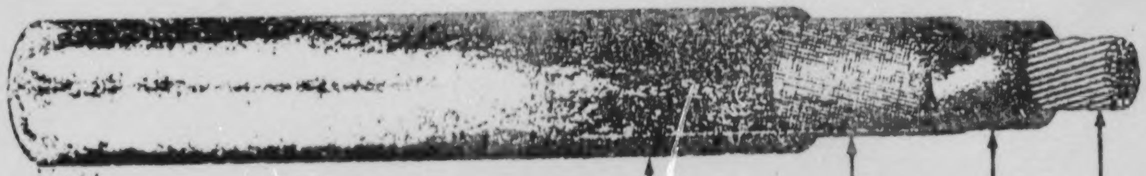
CABLE TYPE 3C


ASBESTOS
BRAID
PRIMARY INSULATION
CONDUCTOR

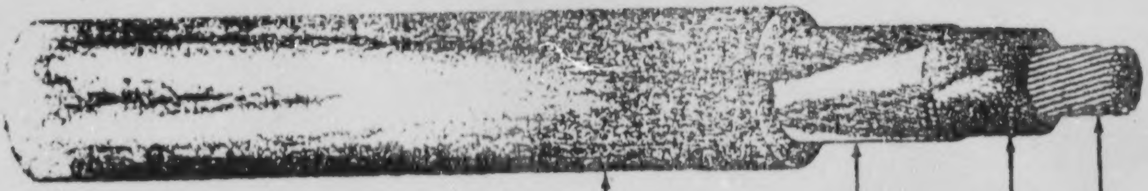
CABLE TYPE 3D


BRAID
BEDDING
PRIMARY INSULATION
CONDUCTOR

CABLE TYPE 3E

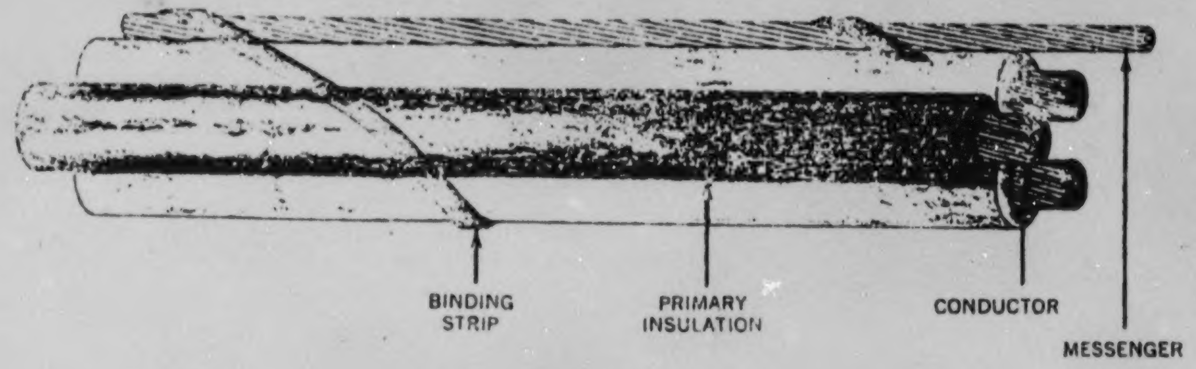

CABLE JACKET
BEDDING
PRIMARY INSULATION
CONDUCTOR

CABLE TYPE 3F

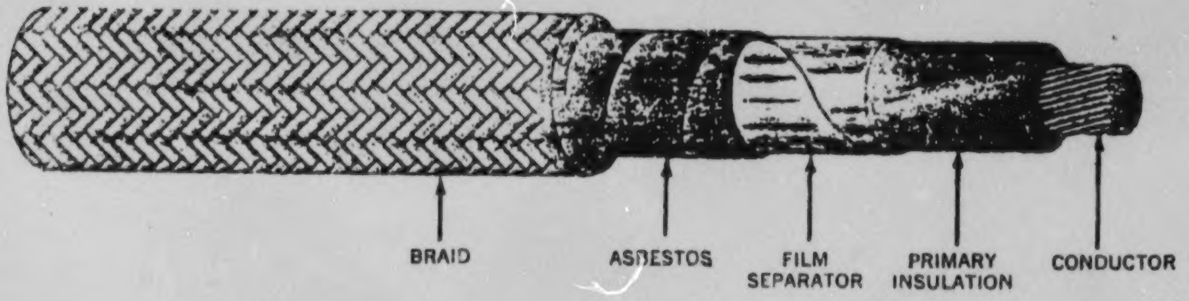

CABLE JACKET
SEMI-CONDUCTING OR BEDDING MATERIAL
PRIMARY INSULATION
CONDUCTOR

466

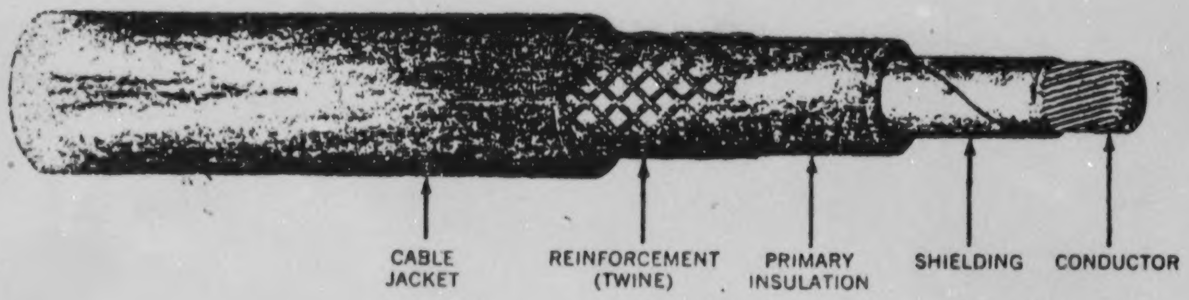
CABLE TYPE 3M


BINDING STRIP
PRIMARY INSULATION
CONDUCTOR
MESSENGER

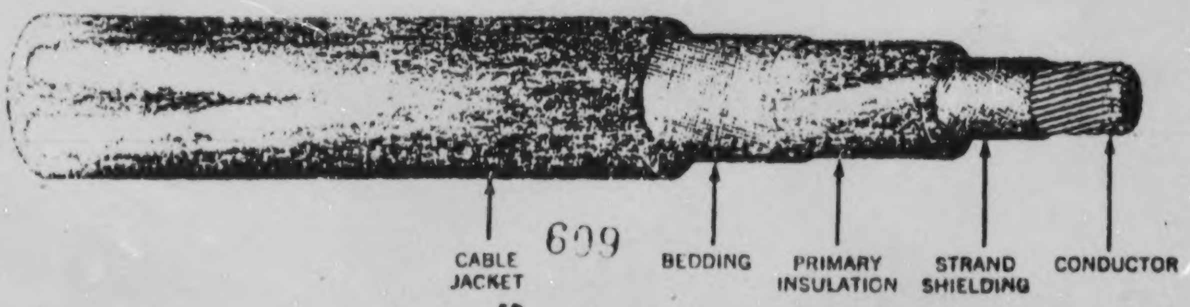
CABLE TYPE 4A


BRAID
ASBESTOS
FILM SEPARATOR
PRIMARY INSULATION
CONDUCTOR

CABLE TYPE 4B


CABLE JACKET
REINFORCEMENT (TWINE)
PRIMARY INSULATION
SHIELDING
CONDUCTOR

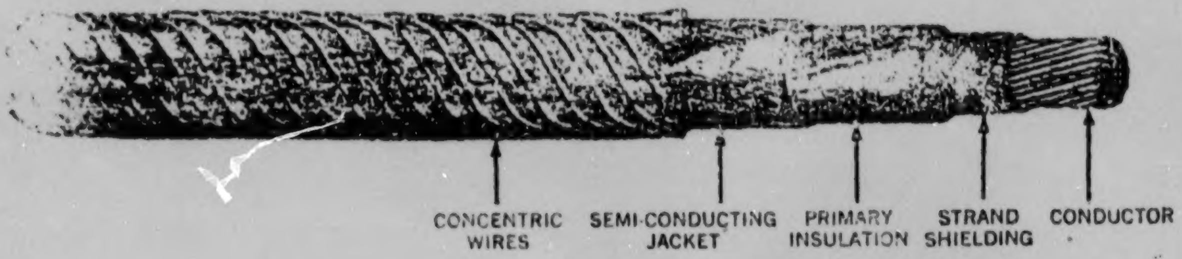
CABLE TYPE 4C


CABLE JACKET
BEDDING
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

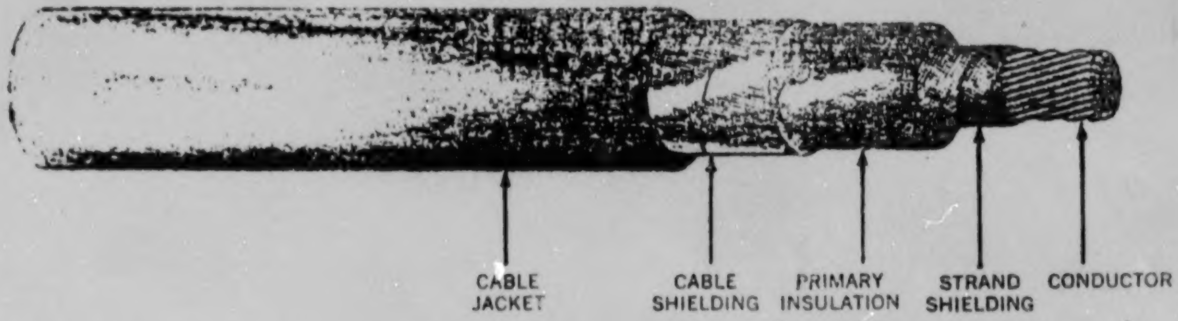
609

13.

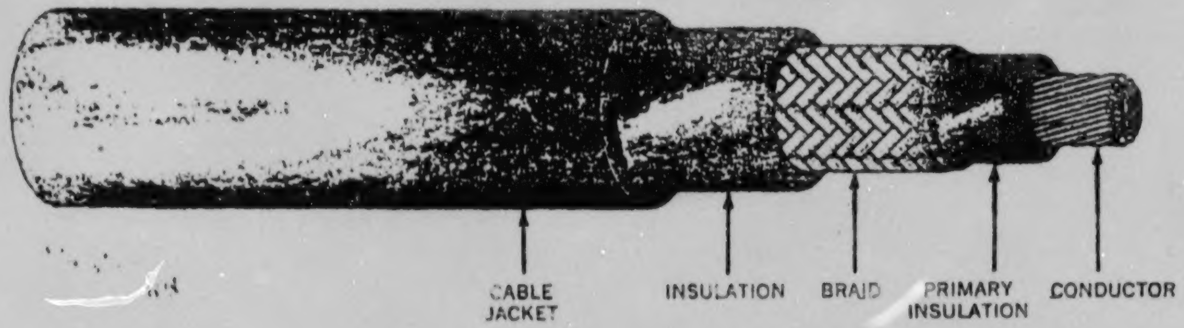
CABLE TYPE 4D


CONCENTRIC WIRES
SEMI-CONDUCTING JACKET
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

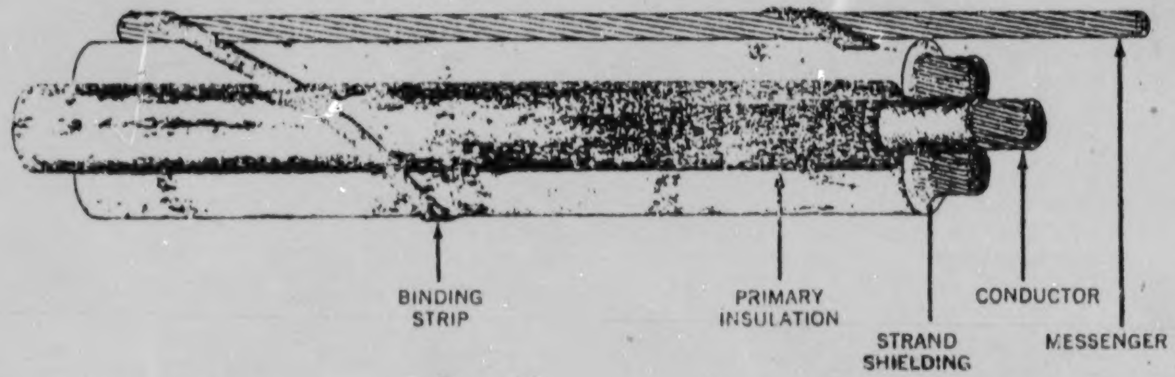
CABLE TYPE 4E


CABLE JACKET
CABLE SHIELDING
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

CABLE TYPE 4F SIGNAL CABLE


CABLE JACKET
INSULATION
BRAID
PRIMARY INSULATION
CONDUCTOR

CABLE TYPE 4M

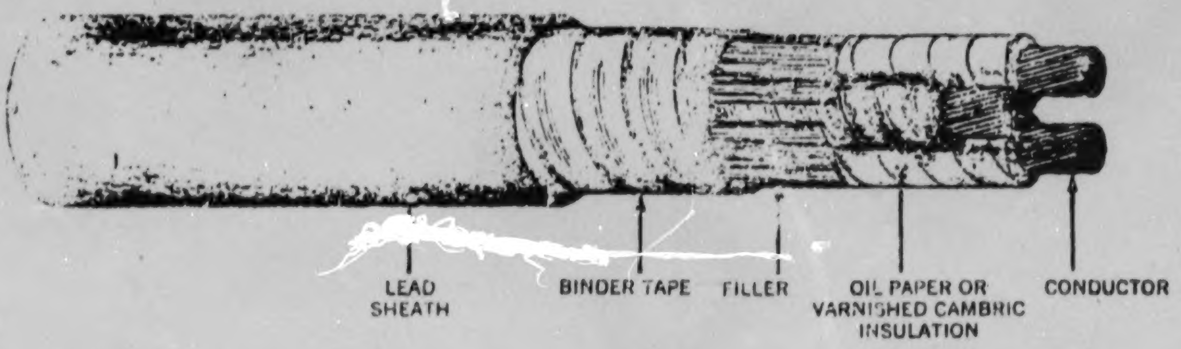

BINDING STRIP
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR
MESSENGER

14.

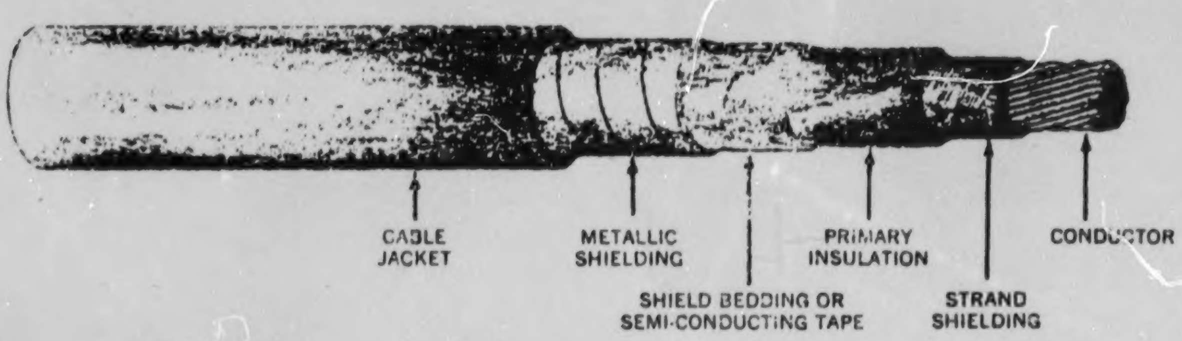
610

468

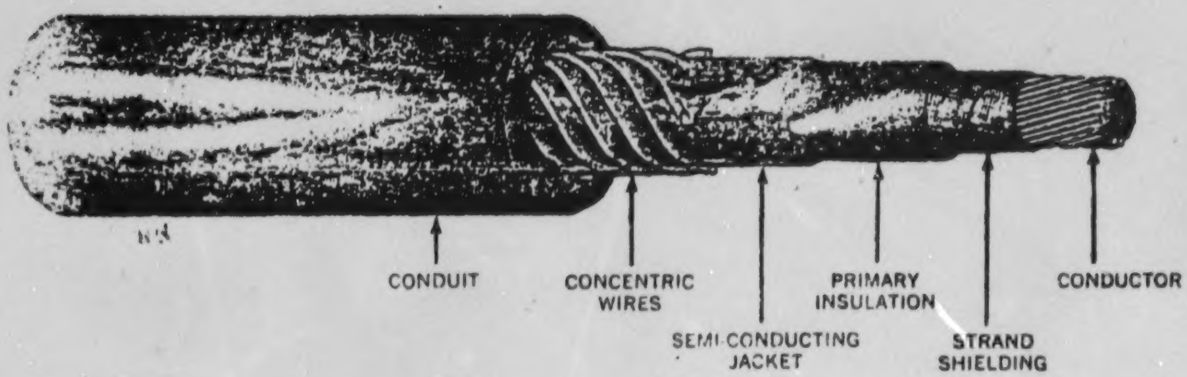
CABLE TYPE 4P


LEAD SHEATH
BINDER TAPE
FILLER
OIL PAPER OR VARNISHED CAMBRIC INSULATION
CONDUCTOR

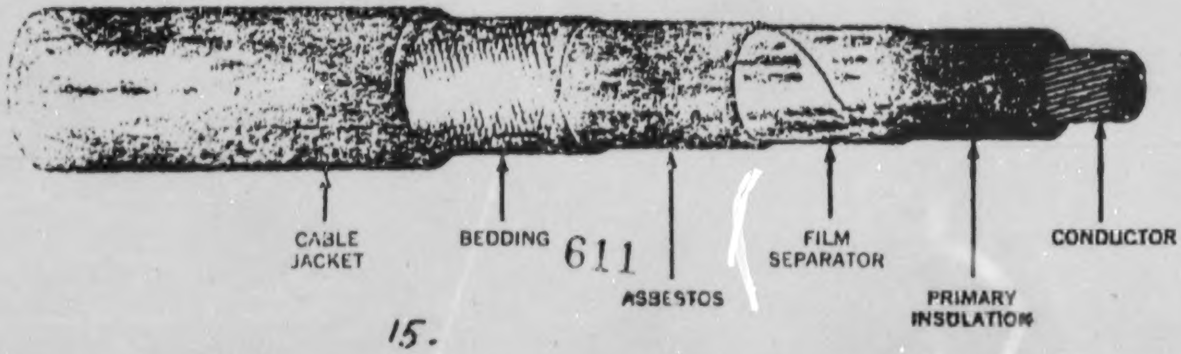
CABLE TYPE 5A


CABLE JACKET
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

CABLE TYPE 5B

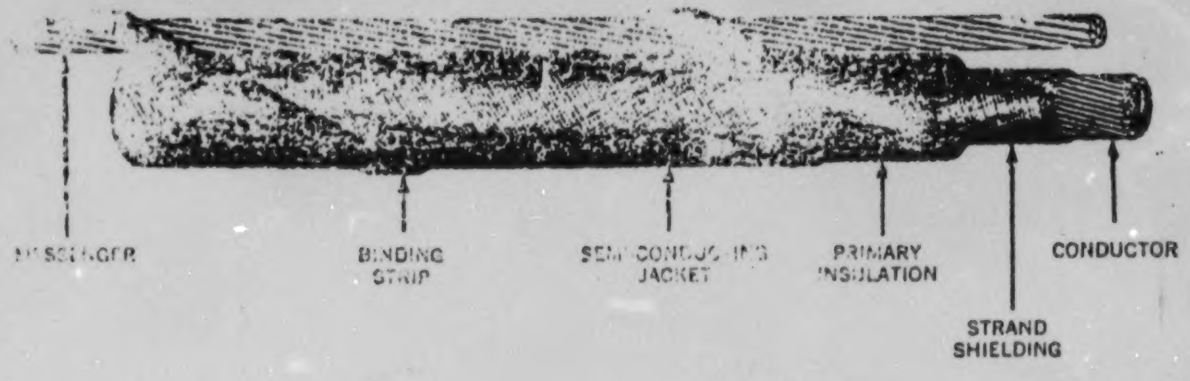

CONDUIT
CONCENTRIC WIRES
SEMI-CONDUCTING JACKET
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

CABLE TYPE 5C

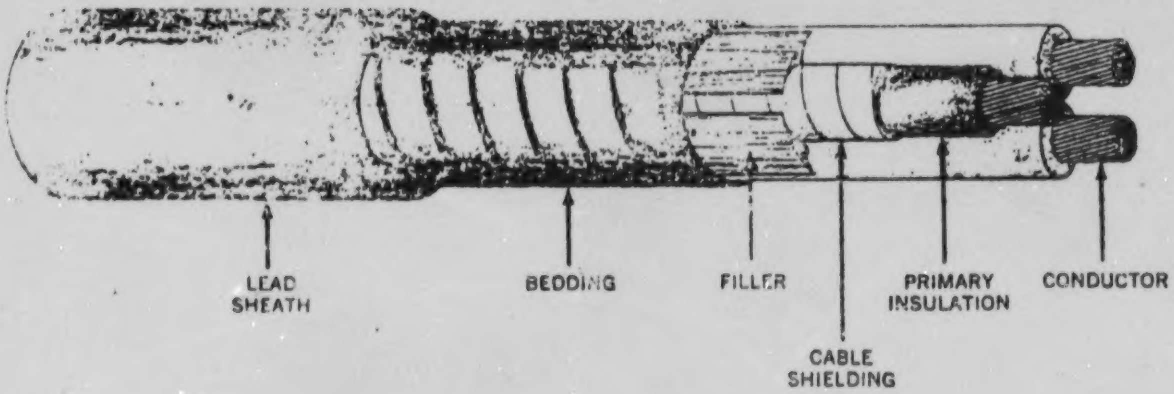

CABLE JACKET
BEDDING
ASBESTOS
FILM SEPARATOR
PRIMARY INSULATION
CONDUCTOR

611

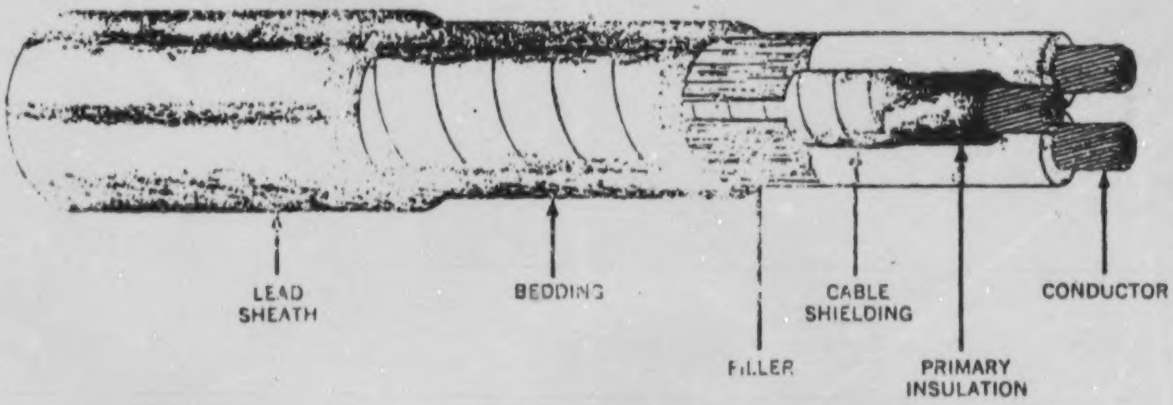
CABLE TYPE 5D


MESSENGER
BINDING STRIP
SEMI-CONDUCTING JACKET
PRIMARY INSULATION
CONDUCTOR
STRAND SHIELDING

CABLE TYPE 5M

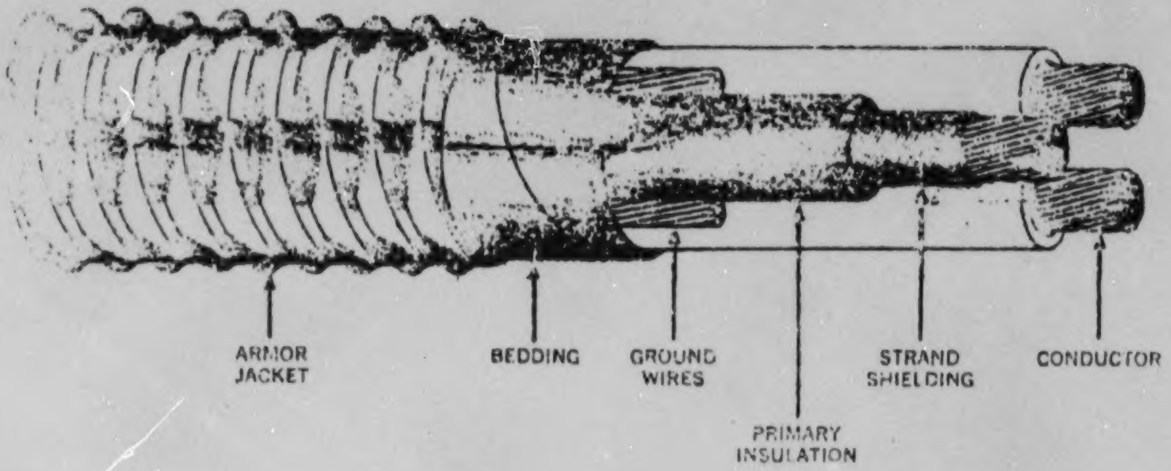

LEAD SHEATH
BEDDING
FILLER
PRIMARY INSULATION
CONDUCTOR
CABLE SHIELDING

CABLE TYPE 5M (HEAVY DUTY)

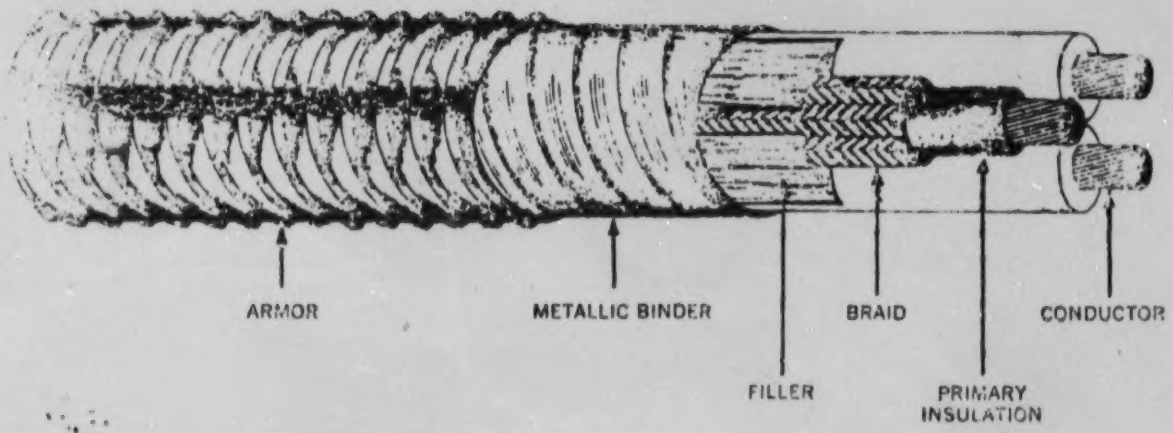

LEAD SHEATH
BEDDING
CABLE SHIELDING
CONDUCTOR
FILLER
PRIMARY INSULATION

16.

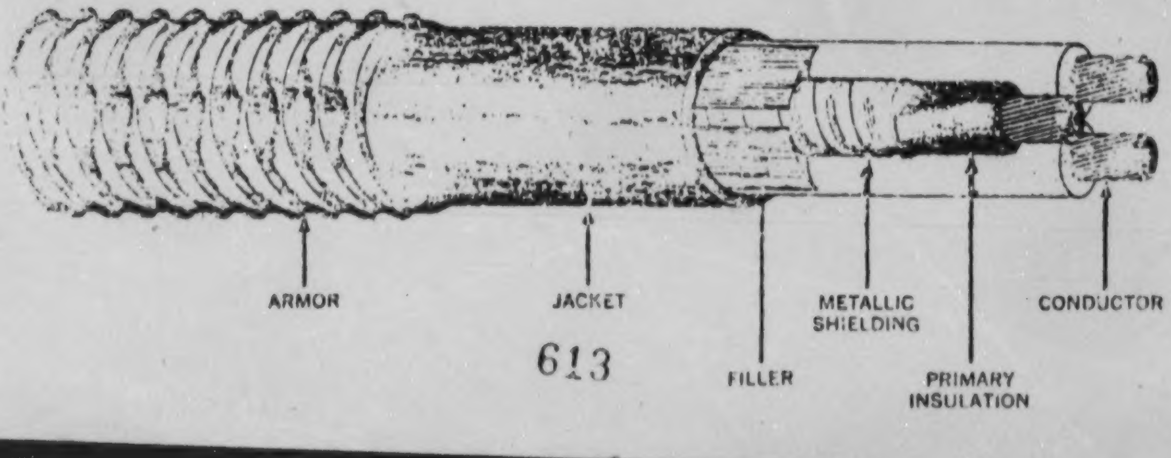
CABLE TYPE 5P


ARMOR JACKET
BEDDING
GROUND WIRES
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

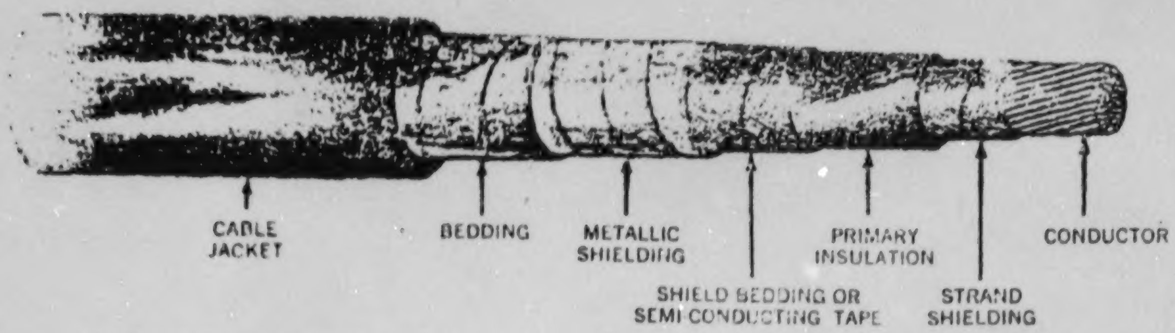
CABLE TYPE 5Q


ARMOR
METALLIC BINDER
FILLER
BRAID
PRIMARY INSULATION
CONDUCTOR

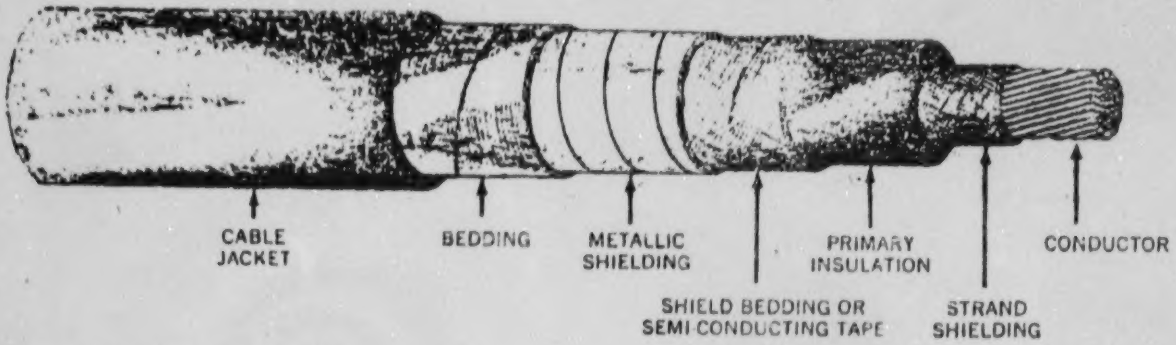
CABLE TYPE 5R


ARMOR
JACKET
FILLER
METALLIC SHIELDING
PRIMARY INSULATION
CONDUCTOR

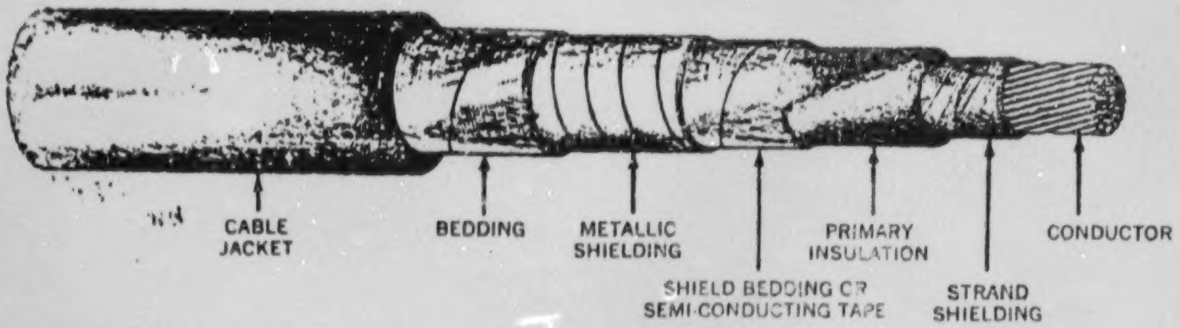
CABLE TYPE 6A


CABLE JACKET
BEDDING
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

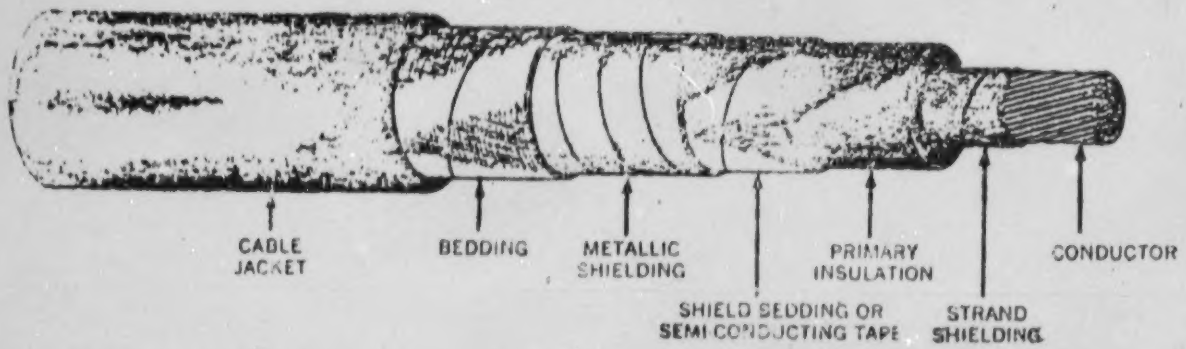
CABLE TYPE 6A (HEAVY DUTY)


CABLE JACKET
BEDDING
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

CABLE TYPE 6B


CABLE JACKET
BEDDING
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

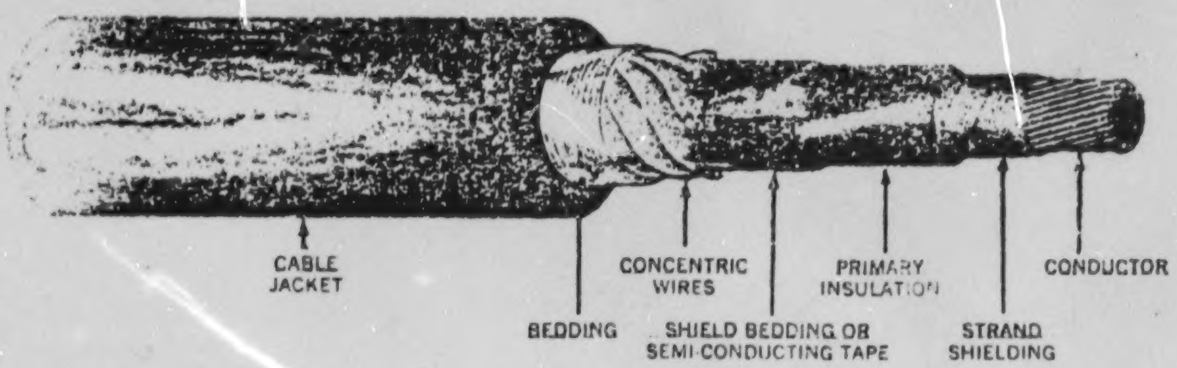
CABLE TYPE 6B (HEAVY DUTY)


CABLE JACKET
BEDDING
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

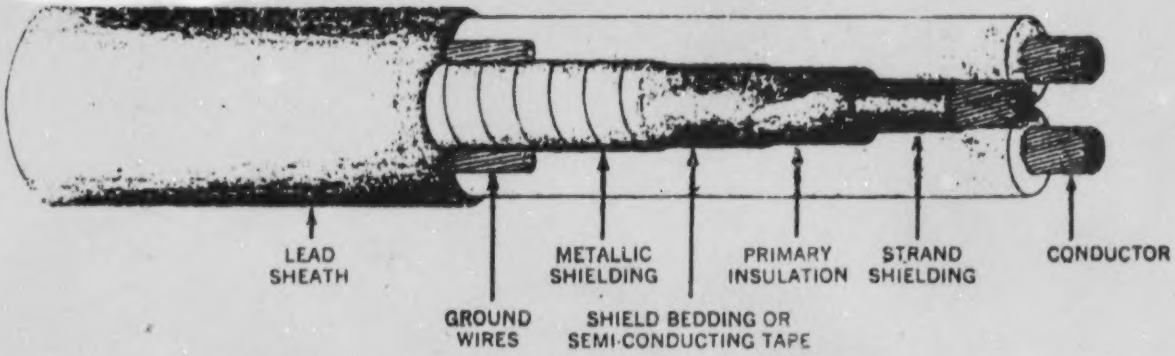
18. 614

472

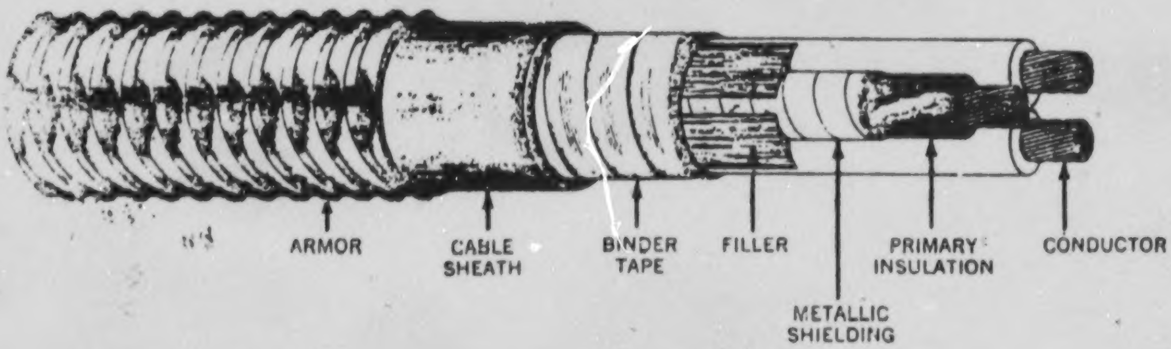
CABLE TYPE 6C


CABLE JACKET
CONCENTRIC WIRES
PRIMARY INSULATION
CONDUCTOR
BEDDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
STRAND SHIELDING

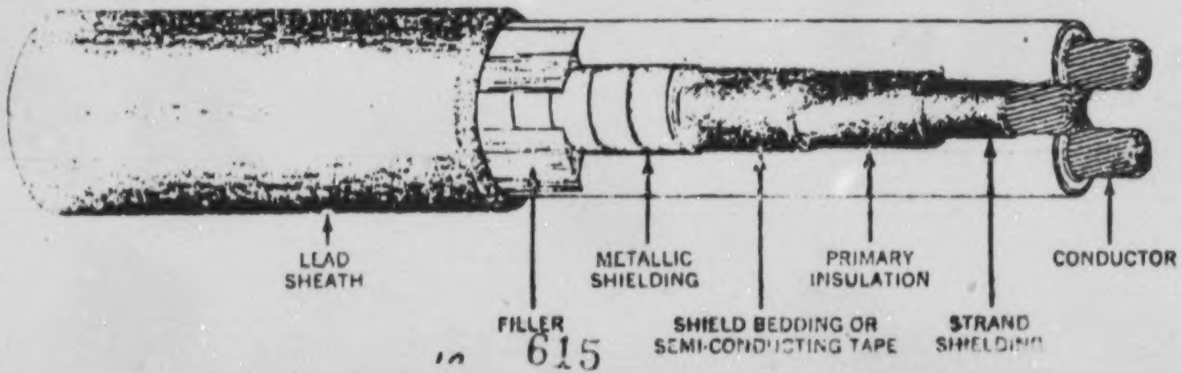
CABLE TYPE 6M


LEAD SHEATH
METALLIC SHIELDING
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR
GROUND WIRES
SHIELD BEDDING OR SEMI-CONDUCTING TAPE

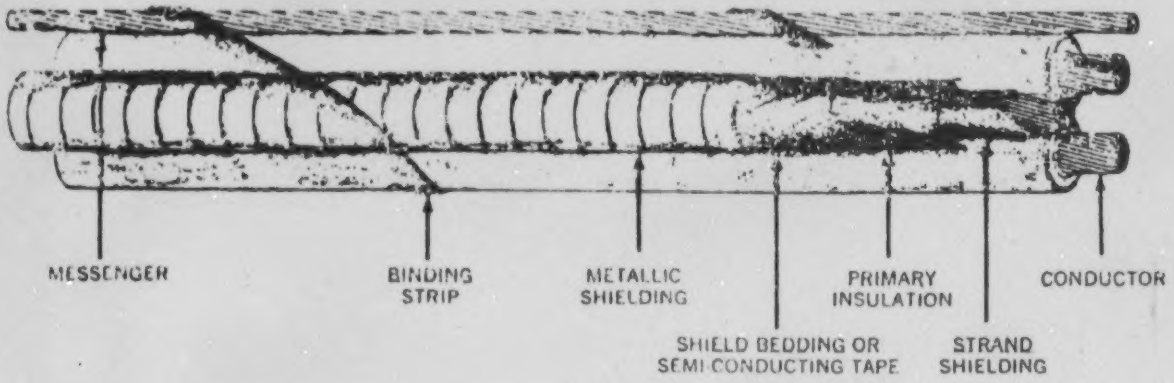
CABLE TYPE 6N


ARMOR
CABLE SHEATH
BINDER TAPE
FILLER
PRIMARY INSULATION
CONDUCTOR
METALLIC SHIELDING

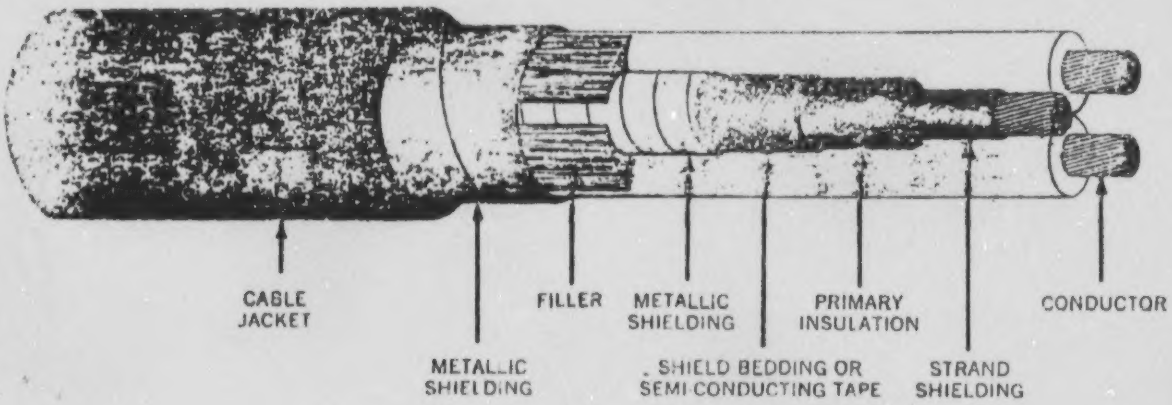
CABLE TYPE 6P


LEAD SHEATH
METALLIC SHIELDING
PRIMARY INSULATION
CONDUCTOR
FILLER
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
STRAND SHIELDING

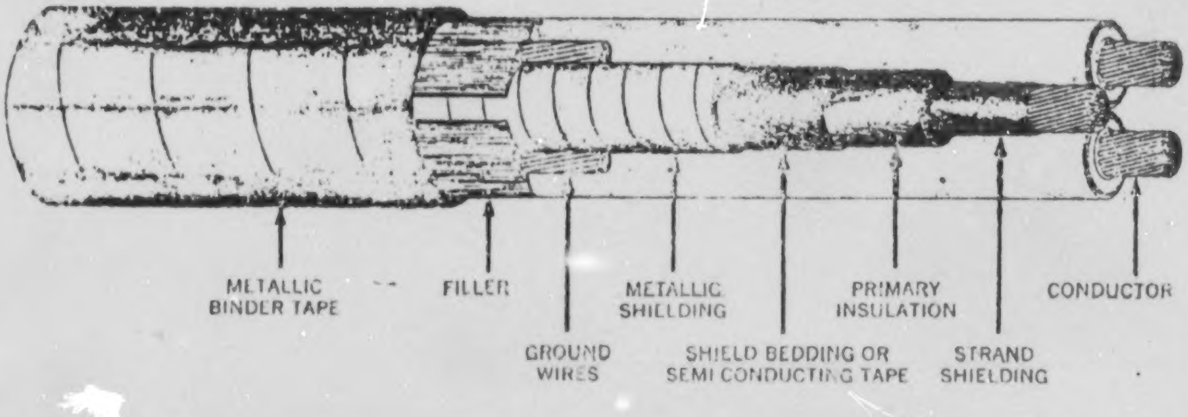
CABLE TYPE 6Q


MESSENGER
BINDING STRIP
METALLIC SHIELDING
PRIMARY INSULATION
CONDUCTOR
SHIELD BEDDING OR SEMI CONDUCTING TAPE
STRAND SHIELDING

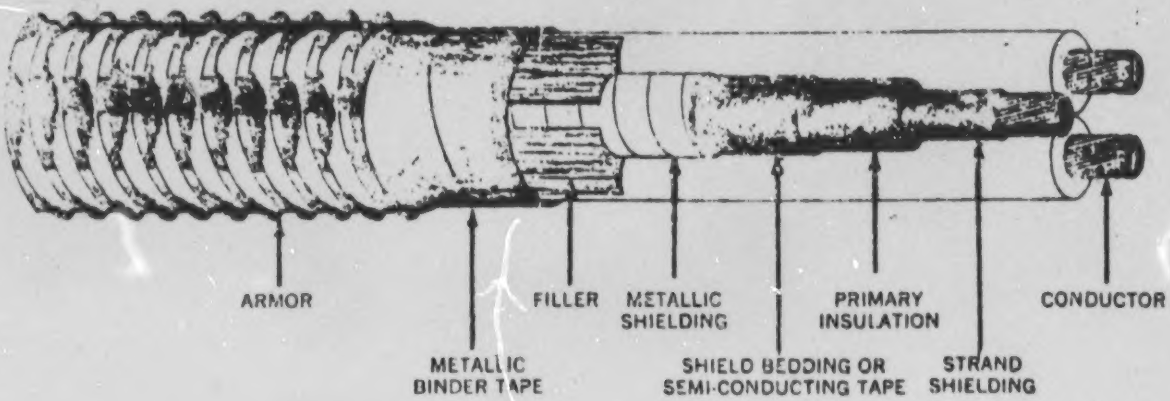
CABLE TYPE 7M


CABLE JACKET
FILLER
METALLIC SHIELDING
PRIMARY INSULATION
CONDUCTOR
METALLIC SHIELDING
SHIELD BEDDING OR SEMI CONDUCTING TAPE
STRAND SHIELDING

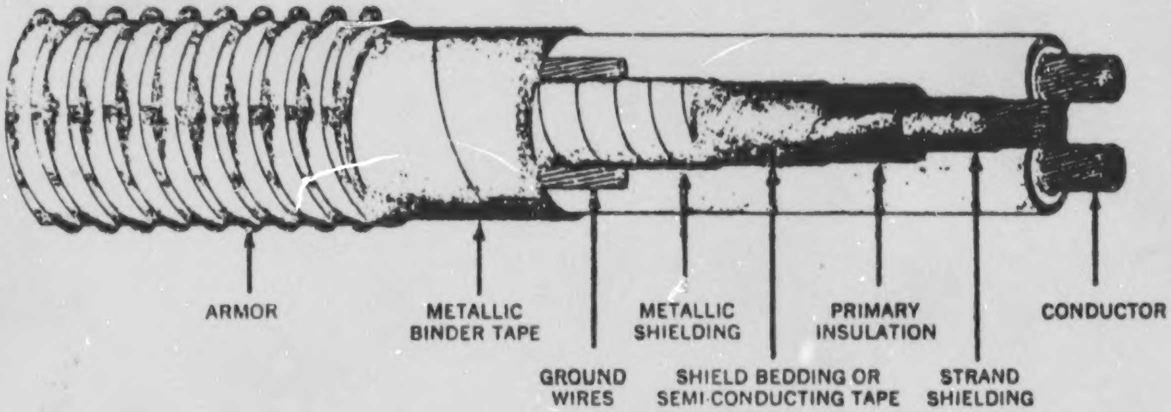
CABLE TYPE 7N


METALLIC BINDER TAPE
FILLER
METALLIC SHIELDING
PRIMARY INSULATION
CONDUCTOR
GROUND WIRES
SHIELD BEDDING OR SEMI CONDUCTING TAPE
STRAND SHIELDING

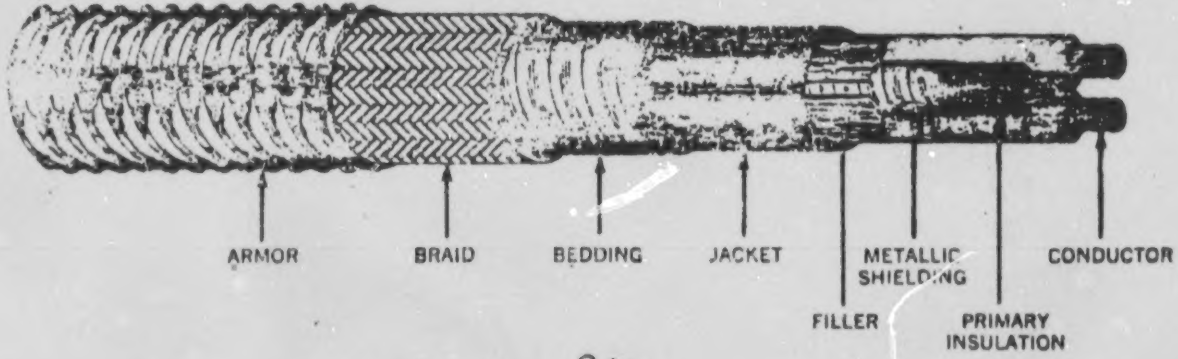
CABLE TYPE 7P


ARMOR
METALLIC BINDER TAPE
FILLER
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

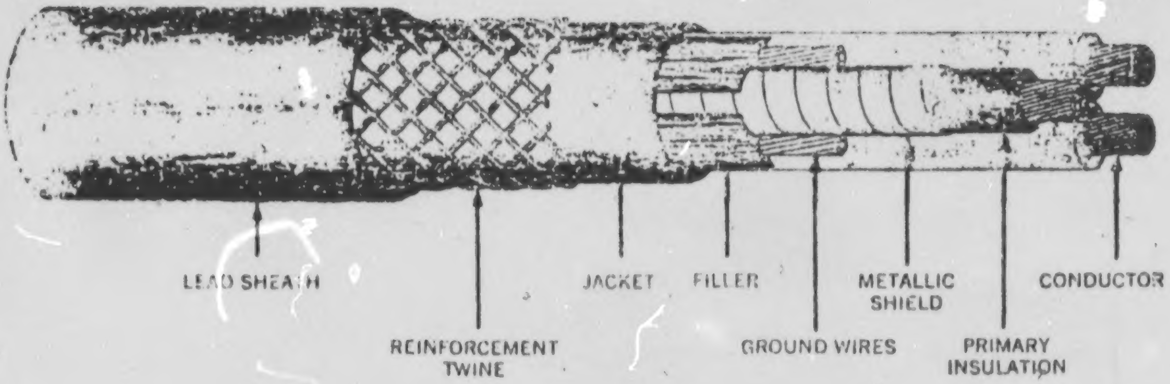
CABLE TYPE 7Q


ARMOR
METALLIC BINDER TAPE
GROUND WIRES
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

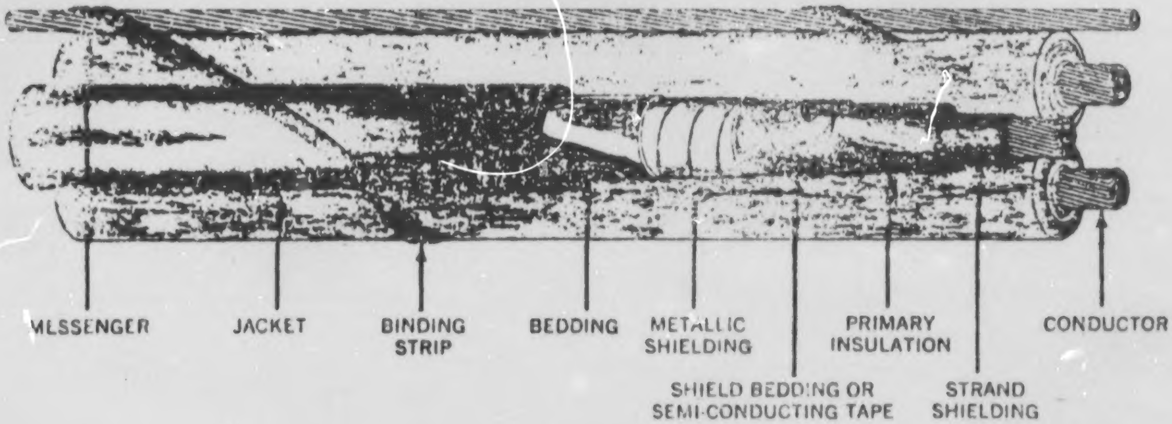
CABLE TYPE 7R


ARMOR
BRAID
BEDDING
JACKET
FILLER
METALLIC SHIELDING
PRIMARY INSULATION
CONDUCTOR

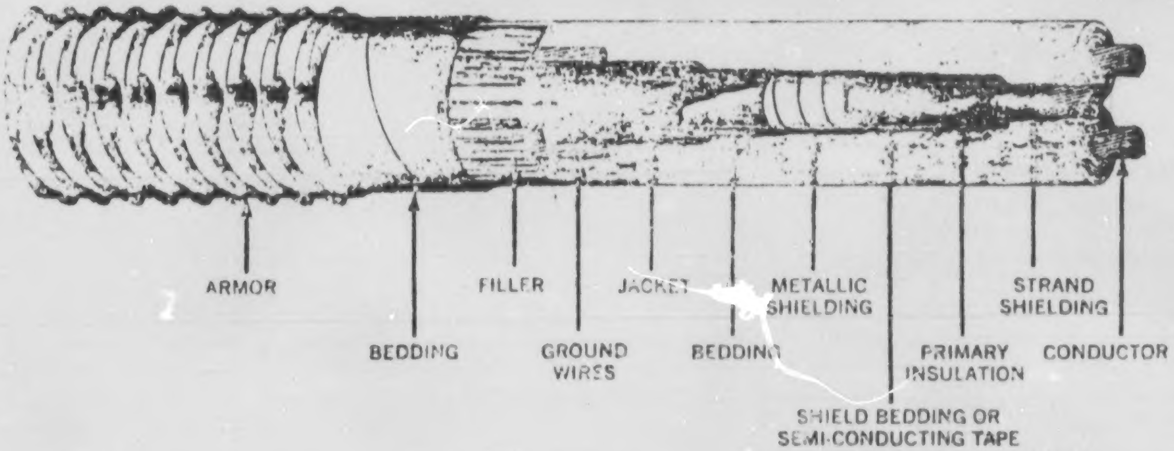
CABLE TYPE 7S


LEAD SHEATH
REINFORCEMENT TWINE
JACKET
FILLER
GROUND WIRES
METALLIC SHIELD
PRIMARY INSULATION
CONDUCTOR

CABLE TYPE 8M


MESSENGER
JACKET
BINDING STRIP
BEDDING
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

CABLE TYPE 10M


ARMOR
BEDDING
FILLER
GROUND WIRES
JACKET
BEDDING
METALLIC SHIELDING
SHIELD BEDDING OR SEMI-CONDUCTING TAPE
PRIMARY INSULATION
STRAND SHIELDING
CONDUCTOR

22 618

476

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.1.1J

(TITLE) 5 KV (5000 VOLTS) "SCOTCHCAST" 82-SERIES SPLICING KIT INSTRUCTIONS

INTRODUCTION:

This job sheet is designed for your use and it provides the necessary information that is needed to complete the assigned splice. Before you proceed read the entire job sheet and any instructions that may be included with the kit.

Once the splicing has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of insulation to the atmosphere.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicers must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

REFERENCE:

Underground Systems Reference Book, 1957, Edison Electric Institute.

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Compression tool, TBM-2
3. Hacksaw
4. Sharpening stone
5. Cable, 5 kv, (RR), AWG #8, 1/C; 5 ft. per student
6. "Scotchcast" splicing kit, 82-A3 or equal; 1 ea. per student
7. Connector, T&B No. 54504, #8 AWG (Red) or equal

JOB STEPS

1. Prepare cable
    a. Arrange the cables into the desired final position

JOB SHEET 1.3.1.1J (continued)

    (1) Avoid severe bending

    (2) Allow slight overlap of ends

b. Cut cables to butt squarely together at desired center line of the splice.

c. Thoroughly clean nine (9) to ten (10) inches back from each cable end.

d. Prepare cable ends as shown in manfacturer's instructions for "Scotchcast" Splicing Kit, 82-A3.

NOTE: Keep cable clean; be sure all conductive thread or tape is removed from sheath opening.

CAUTION: Do not cut insulation when removing outer sheath.

e. Remove insulation as required to fit one half connector length plus one half inch on each cable end.

f. Pencil insulation one half inch or approximately one (1) cable diameter.

g. Remove all conductive thread or tape from around conductor.

CAUTION: Do not nick the conductor.

2. Make connection

a. Make connection according to instructions for connector being used.

b. Good quality connectors of smooth compact shape such as an:

    (1) Indent sleeve

    (2) Solder sleeve

    (3) Compression sleeve

c. Multi-conductor cables - stagger individual connections and insulate with scotch brand electrical tape #23.

NOTE: Choice of connector is left to user.

3. Tape over connector area

a. Use scotch #23 self bonding tape or equal (provided with kit).

JOB SHEET 1.3.1.1J (continued)

b. Apply one layer half-lapped over connector area only (one quarter inch on to pencil).

CAUTION: Do not wrap #23 tape beyond penciled area.

IMPORTANT: Stretch tape to 1/2 original width.

4. Install mold body

   a. Trim mold ends with knife to fit cable slightly loose.

   b. Center mold halves over splice and snap together firmly

   c. Insert pouring spouts in holes

   d. Check to see that both seams are carefully snapped together.

CAUTION: It is important that cables and connectors are centered in mold.

5. Tape ends of mold body, around cable to seal, use scotch #23 supplies with the kit.

IMPORTANT: Stretch tape to 1/2 original width.

6. Pour splice

   a. Position splice level

   b. Mix resin thoroughly per instructions on "Unipak" guard bag.

   c. Pour resin immediately after mixing

   d. Fill mold through one spout ONLY until both spouts are completely filled (to allow for cooling shrinkage).

NOTE: A slight raise of one end and by pouring into the lower end will allow the air to flow out of the kit freely.

   e. When resin has solidified and cooled the splice may be put into service (30 to 45 minutes).

   f. Clip off spouts if desired and tape over the openings.

INSTRUCTOR'S INITIALS ____________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.2.1J

(TITLE) 5 KV RUBBER INSULATED LEAD COVERED JOINT CONSTRUCTION

INTRODUCTION:

This job sheet is designed to be used by you for actual step-by-step splicing procedures for splicing rubber insulated-lead sheath, single conductor cable using straight and branch joints. Application of these splicing procedures is essential to good trouble free power service. These instructions do not purport to cover all details or variations in equipment nor provide for every contingency to be met in connection with installation, operation, or maintenance.

Before starting work, see that the drawing of that joint to be built, the tools and materials, are all at the site of installation. Once the splicing has begun, it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of insulation to the atmosphere.

Satisfactory cable joints are largely dependent upon the quality of workmanship, therefore, the splicers must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

Read the entire job sheet first, then, look over all of the joints and terminations. Turn to the first joint drawing and begin splicing, following proper steps of procedure and observing all safety precautions.

REFERENCE:

Underground Systems Reference Book, 1957, Edison Electric Institute.

EQUIPMENT AND MATERIALS

1. Screwdriver, 1/4" X 4"
2. Screwdriver, 3/8" X 6"
3. Shoemaker's knife
4. Chipping knives
    a. Small
    b. Large
5. Six (6) foot folding rule (wooden)
6. Wooden separators
7. Safety goggles
8. Splicer's cotton gloves (long wristlet)
9. Compound temperometer

JOB SHEET 1.3.2.1J (continued)

10. Wiping cloths
    a. 2" X 2"
    b. 3" X 3"
    c. 4" X 4"
11. Catch cloths
    a. 6" X 6"
    b. 8" X 8"
12. Rasp half round and handle
13. File and handle
14. File cleaning brush
15. Cableman's saw and guard
16. Pliers
    a. Side-cutting (lineman's)
    b. Diagonal-cutting
    c. Eagle-claw (beaks)
    d. Channel-locks
17. Cable splicer's mirror
18. Cable dresser (wooden)
19. Tinner's hammer (riveting)
20. Soldering irons and handles
    a. 2 lb. (copper)
    b. 4 lb. (copper)
21. Shave hook
22. Steel tool box
23. Melting pot (solder)
    a. Electric
    b. Cast iron
24. Tool pan
25. Solder catch pan
26. Oil catch pan
27. Compound kettles
28. Solder ladles
29. Cable cutters, hydraulic
30. Cable cutters, hand
31. Connector compression tool (Burndy)
32. Wood drift pin (or piece of pipe)
33. Gas furnace
    a. Propane
    b. Gasoline (white)
34. Folding windshield
35. Pot hook handle
36. Connectors
    a. Solder-sweated, split tinned type
    b. Compression type (Burndy type)
37. Insulating materials
    a. Tapes

JOB SHEET 1.3.2.1J (continued)

        (1) Rubber (3M Co. #23 or equal)
        (2) Synthetic
        (3) Friction and/or anhydrous
        (4) Cotton
            (a) One-half inch (1/2")
            (b) One inch (1")
        (5) Plastic (Scotch #33 plus)
    b. Filling materials
        (1) Plastic, oil-insoluble
        (2) Plastic, oil-soluble
        (3) Plastic, resin

38. Lead sleeves
39. Lead crotch pieces - size A-1
40. Abrasive cloth (non-conducting)
41. Solder 40/60 wiping
42. Solder 50/50 seam
43. Stearine candles
44. Copper braid tape (tinned)
45. Paper pasters
46. Tinned copper wire #14
47. Wiping rags
48. Cable, 5 kv, (R-L), AWG # 4/0, 1/C

JOB STEPS:

1. Cable preparation

    a. Make sure power cables are not energized before starting work.

    b. Arrange the cables into the desired final position.

        (1) Avoid severe bending

        (2) Allow slight overlap of ends

    c. Cut cables to butt squarely together at desired centerline of splice.

    NOTE: The cable on one side of centerline must be straight enough to allow for sliding the sleeve back while making the joint. On branch-joint slide the sleeve over the splice end having only one cable.

2. Preparation of lead sleeve

    a. Scrape both ends of the sleeve for 3 or 4 inches with a rasp or shave hook.

    b. Apply stearine flux to cleaned portions

JOB SHEET 1.3.2.1J (continued)

c. Beat down one end of the sleeve to slightly larger than cable diameter.

d. Slide beat down end first over one end of the cable.

3. Removing the lead sheath

a. Measure and mark the sheath at a distance "A" from each cable end.

NOTE: Allow 1/2" of conductor on each end of connector.

b. Score the sheath to a depth slightly less than 1/2 of its thickness completely around the cable at this mark using the chipping knife and tinners hammer.

c. Scrape the sheath clean on each cable for at least 3 inches beyond the score and apply stearine flux.

d. Apply paper pasters on cable ends.

(1) One to cover the score plus 1/2 inch of the cleaned portion.

(2) One at the other end of the cleaned area.

e. Tin cleaned portion of cable sheath.

CAUTION: DO NOT burn through cable sheath.

f. Remove paper pasters.

g. Slit the sheath up to the score from each end, being careful not to injure the insulation using a chipping knife and tinners hammer.

h. Tear the lead sheath off in such a manner that a neat bell is formed at the end of the sheath.

4. Preparation of each end for connector.

a. Remove semi-conducting tape to the lead sheath.

CAUTION: DO NOT cut the conductor insulation.

b. Remove insulation and internal shielding tape from each cable end for a distance of one-half (1/2) the length of connector plus one-half (1/2) inch using a sharp knife.

CAUTION: DO NOT nick the conductor.

c. Protect the ends of the exposed insulation from the heat of soldering by wrapping with a dry cotton tape back to the lead sheath.

5. Placing and soldering of connector.

   a. Clean the exposed conductor thoroughly and apply stearine flux.

   b. Phase conductors (if required).

   c. Fit the conductor ends into the connector with ends butting firmly in center and with the slot or hole in the connector on top.

   d. Hold the assembly in this position and squeeze the connector tightly onto the conductors.

   NOTE: On branch cable use correct connector or wrap using a #14 tinned copper wire. Branch cable size not to exceed main cable size.

   e. Apply heat and solder, making sure that connector and all dents caused by squeezing get filled with solder.

   f. Remove excess solder and smooth off all burrs.

6. Preparation of splice for insulation.

   a. Remove the protective covering from ends of insulation.

   b. Pencil the insulation or trim.

   CAUTION: Handle carefully and keep knife sharp. DO NOT nick conductor.

   c. Clean and roughen the penciled portion and exposed insulation with a coarse file or non-conducting abrasive cloth.

   d. Wipe clean with a dry cloth or wash the roughened surfaces of the connector and exposed conductor with a cleaning agent such as white gasoline or naphtha applied to a clean cloth.

   NOTE: Make sure that no conducting particles remain on the insulation.

7. Insulating the splice.

a. Apply rubber cement to roughened surfaces, the connector and the exposed conductor and allow it to dry until tacky.

b. Insulate at small diameter areas at end of connector first.

NOTE: Fill in crotch area with folded layer of tape on the branch-joint side.

c. Apply ozone resistant rubber splicing tape, with approximately 50% overlap, to a thickness over the connector of one and one-half (1-1/2) times the factory applied insulation and taper down to edge of sheath on each conductor.

NOTE: Tape should be applied with enough tension so that its width when applied is two-thirds (2/3) of its original width.

d. Apply two layers of friction tape half-lapped (50% overlap) over rubber tape.

8. Closing the splice opening.

a. Center lead sleeve over splice.

b. Dress down sleeve ends to the cable sheath.

NOTE: On branch joint ensure lead crotch piece is spot soldered in place between branch conductors and tinned before dressing sleeve ends down. The crotch piece should be one inch (1") from end of lead sheath.

c. Apply paper pasters.

(1) One-half inch (1/2") from sleeve on sheath for cables of one-inch (1") and under diameter.

(2) Three quarter of an inch (3/4") for cables one inch (1") to three inch (3") diameter on sheath.

(3) On sleeve apply at the ridge of sleeve.

d. Solder tack sleeve ends then wipe sleeve onto cable sheath.

e. Pressure test splice.

9. Filling the joint (bridge joint only for classroom experience).

JOB SHEET 1.3.2.1J (continued)

a. Make two holes in top of the sleeve - each hole to be three inches (3") from end of sleeve and the hole large enough to accommodate the spout of a funnel.

b. Fill the sleeve with ozite ("B") (or similar) compound which is heated to the temperature as shown on the label; this temperature should be checked with a temperometer.

NOTE: Tilt the joint slightly and fill through the lower hole.

c. Level the joint and allow it to stand until it has cooled, and then make a second filling.

d. Close and clean the holes and the lead around them, apply stearine flux and paper pasters then seal the holes carefully with solder.

10. Securing joint and cable.

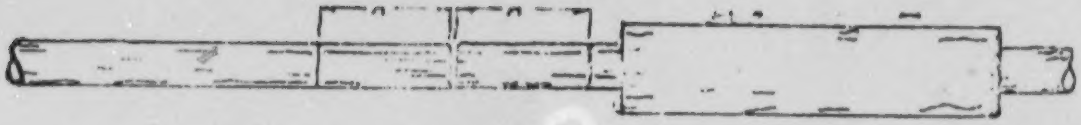
a. Bond cable to other cables and ground.

b. Apply corrosion or fire protection (if required).

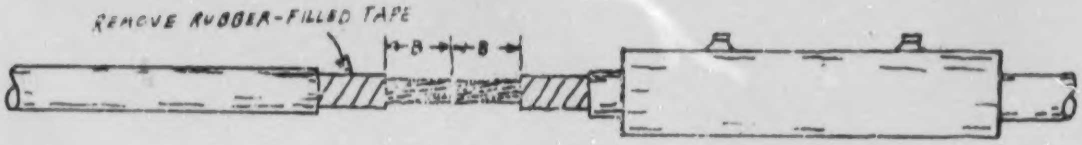
c. Attach identification tag or mark the cable.

INSTRUCTOR'S INITIALS ________________

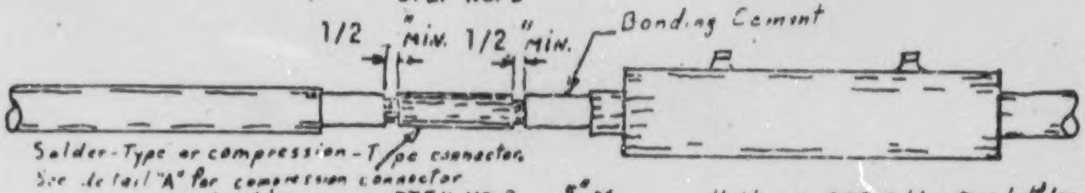
486



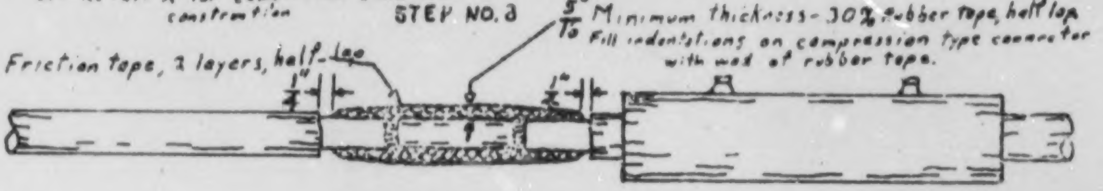
STEP NO. 1


REMOVE RUBBER-FILLED TAPE
B
B

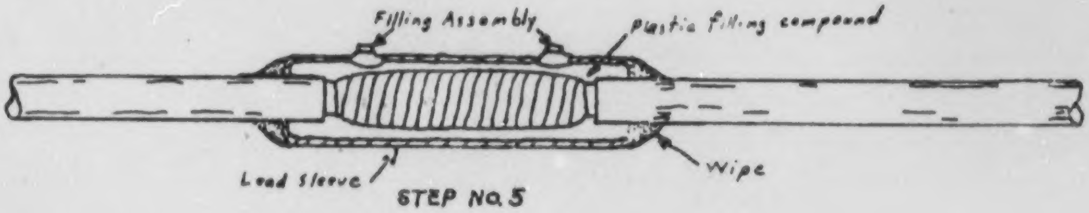
STEP NO. 2


1/2" MIN.
1/2" MIN.
Bonding Cement
Solder-Type or compression-Type connector.
See detail "A" for compression connector construction

STEP NO. 3


5/16" Minimum thickness - 30% rubber tape, half lap
Fill indentations on compression type connector with wad of rubber tape.
Friction tape, 2 layers, half-lap
1/4"
1/4"

STEP NO. 4


Filling Assembly
Plastic filling compound
Lead sleeve
Wipe

STEP NO. 5

*NOTE: Add 1/4 inch to all "A" dimensions

Code No.	Size of Larger Conductor AWG or MCM	DIMENSIONS (INCHES)				
		LEAD SLEEVE		Connector Length	A*	B
		ID	LENGTH			
1	6	1½	10	1½	3½	1
2	3	1½	10	2	3½	1¼
3	2	1½	10	2	3½	1¼
4	2/0	2½	12	2	4½	1¼
5	4/0	2½	12	2½	4½	1½
6	350	2½	12	2½	4½	1½
7	500	2½	13	3	4¾	1¾
8	750	3	14	3½	5	2

629

STRAIGHT JOINT
RUBBER-INSULATED LEAD-COVERED CABLES
5,000 VOLTS

CONSOLIDATED EDISON COMPANY OF N.Y. INC.
ELECTRICAL ENGINEERING DEPARTMENT
OUTSIDE PLANT BUREAU

DATE 2-11-38
Last Rev. 5-11-4?
DWG. NO. EO-1379-C

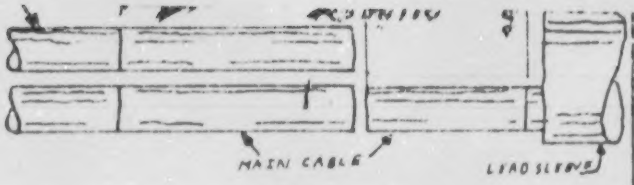
RSV 4

STRAIGHT JOINT
RUBBER-INSULATED LEAD-COVERED CABLE
5,000 VOLTS

DRAWING NO. EO-1573-C, REV. 4

ITEM	SPEC. OR DWG. NO.	UNIT	QUANTITY (3 JOINTS) CODE NO. & SIZE OF LARGER CONDUCTOR (AWG 1, 2 & 3 6, 3 & 2	 4,5 & 6 2/0,4/0&350	 7 500	 8 75
CLOTH. ABRASIVE. GRADE #150 - 1-1/2" WIDE	-	FOOT	6	6	6	12
COMPOUND. FILLING - PLASTIC	E-57-30	PINT	5	5	5	5
CONNECTOR, STRAIGHT OR REDUCING (SEE NOTE)	PB-10,016	EACH	3	3	3	3
CORD. MELROSE	-	INCH	15	15	15	15
FLUX, STEARINE	-	2 OZ. STICK	1	1	1	1
PASTERS. PAPER - 2-1/2" x 12" STRIPS	E-54-30	EACH	9	12	12	18
SLEEVE. LEAD - FOR PLASTIC COMPOUND (I.D. x LENGTH)	EO-1594-C	EACH	3 (1 1/2x9)	3 (2 1/2x11)	3 (2 1/2x12)	3(
SOLDER. PIG (40-60 TIN-LEAD, GRADE 40-A)	EO-100,052	POUND	4	6	6	9
TAPE. FRICTION	EO-6012	ROLL	1	1	1	
TAPE. OZONE RESISTANT RUBBER - 3/4" WIDE	EO-100,001	ROLL	2	3	4	
WIPE RAGS	G-2-39	POUND	1	1	1	

NOTE - SIZE OF CONNECTOR VARIES WITH SIZE OF CONDUCTORS TO BE JOINED

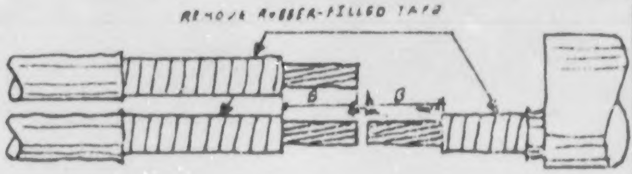

MAIN CABLE
LEAD SLEEVE

STEP–No 1

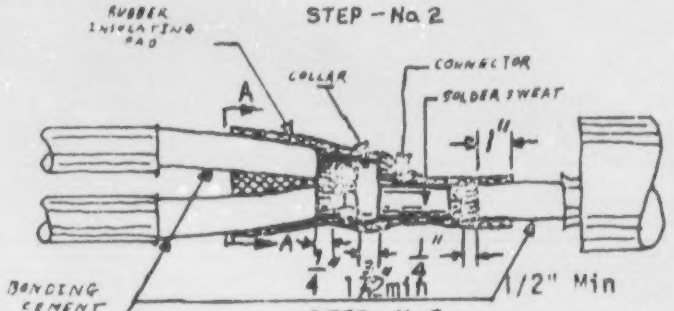
CABLE	CABLE		I.D.	LENGTH	LENGTH		
6	6	1	2½	11	1½	4½	4
3	3	1	3	12	2	5	4½
2/0	2	2	3	12	2	5	4½
2/0	2/0	2	3	12	2	5	4½
4/0	2	2	3½	12	2½	5	4½
4/0	2/0	2	3½	12	2½	5	4½
4/0	4/0	2	3½	12	2½	5	4½
350	150★*		4	14	2½	5	4½
500	500★*		4½	14	3	5¼	4¾

★ MAXIMUM SIZE OF BRANCH CABLE CONDUCTOR.

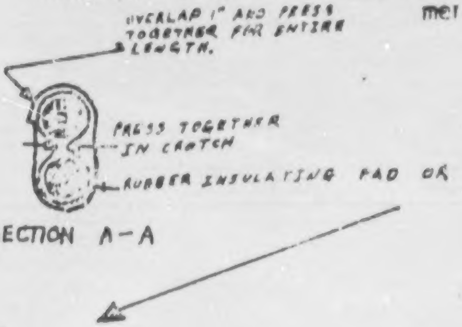
*Add 1/4" to all "B" measureme


REMOVE RUBBER-FILLED TAPE
B
B
A

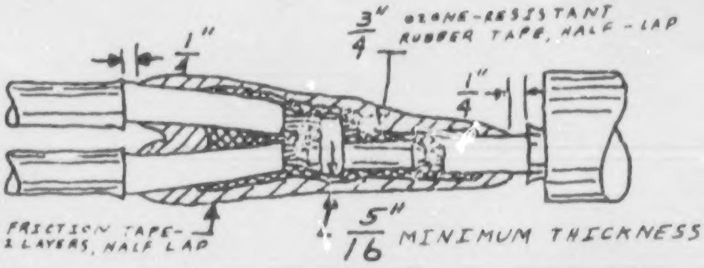
STEP – No 2


RUBBER INSULATING PAD
COLLAR
CONNECTOR
SOLDER SWEAT
A
1"
A
1/4
1 1/2 min
1/4"
1/2" Min
BONDING CEMENT

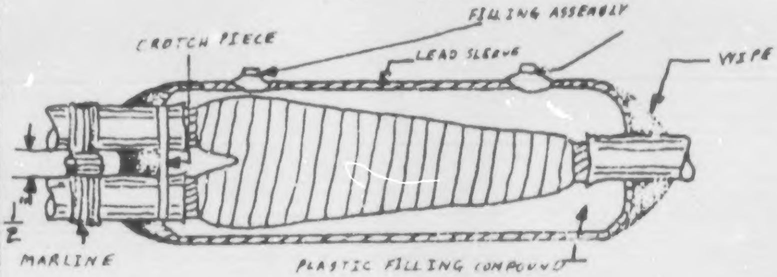
STEP – No.3


OVERLAP 1" AND PRESS TOGETHER FOR ENTIRE LENGTH.
PRESS TOGETHER IN CROTCH
RUBBER INSULATING PAD OR

SECTION A – A


1/2"
3/4" OZONE-RESISTANT RUBBER TAPE, HALF – LAP
1/4"
FRICTION TAPE– 2 LAYERS, HALF LAP
5/16" MINIMUM THICKNESS

STEP – No.4

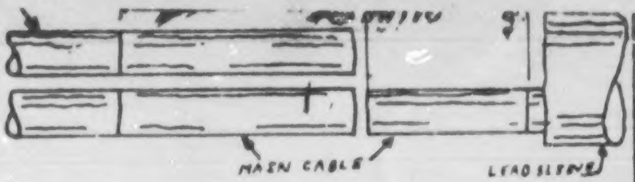

FILLING ASSEMBLY
CROTCH PIECE
LEAD SLEEVE
WIPE
1/2"
MARLINE
PLASTIC FILLING COMPOUND

STEP ––No.5

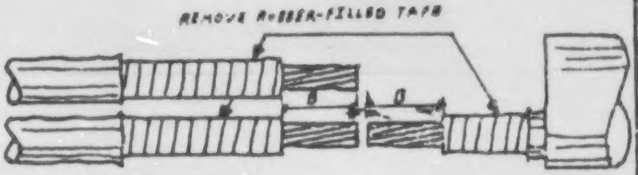
Supersedes Pg 2 of spec E-42-31 and
DWG CP 2816-1

BRANCH JOINT
RUBBER-INSULATED LEAD-COVERED CABLE
5,000 VOLTS

Consolidated Edison Company of N.Y.
Electrical Engineering Department


MAIN CABLE
LEAD SLEEVE

STEP—No.1

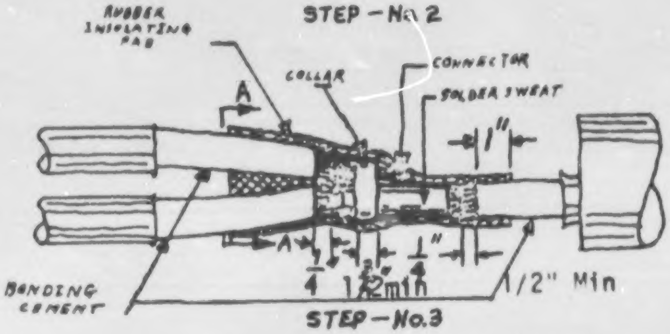

REMOVE RUBBER-FILLED TAPE
B
B

STEP—No.2

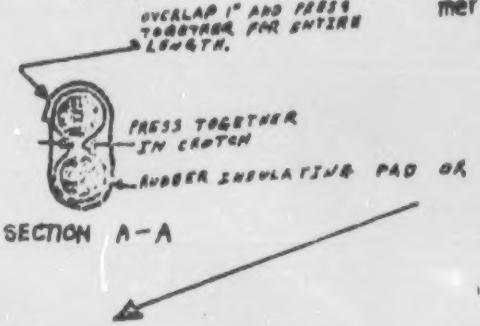
CABLE	CABLE		I & B	LENGTH	LENGTH		
6	6	1	2½	11	1½	4½	4
3	3	1	3	12	2	5	4½
2/0	2	2	3	12	2	5	4½
2/0	2/0	2	3	12	2	5	4½
4/0	2	2	3½	12	2½	5	4½
4/0	2/0	2	3½	12	2½	5	4½
4/0	4/0	2	3½	12	2½	5	4½
350	350★*		4	14	2½	5	4½
500	500★*		4½	14	3	5¼	4¾

*★ MAXIMUM SIZE OF BRANCH CABLE CONDUCTOR.

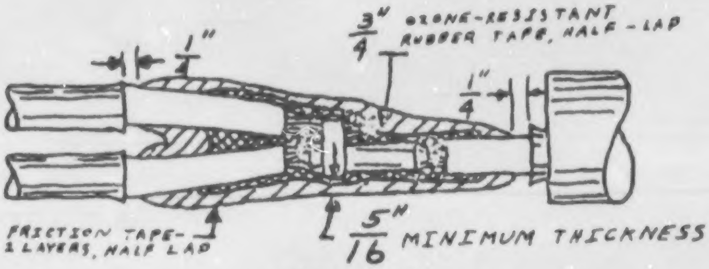
*Add 1/4" to all "B" measuremer


RUBBER INSULATING PAD
COLLAR
CONNECTOR
SOLDER SWEAT
A
1"
A
1/4
1 1/2 min
1/4
1"/4
1/2" Min
BONDING CEMENT

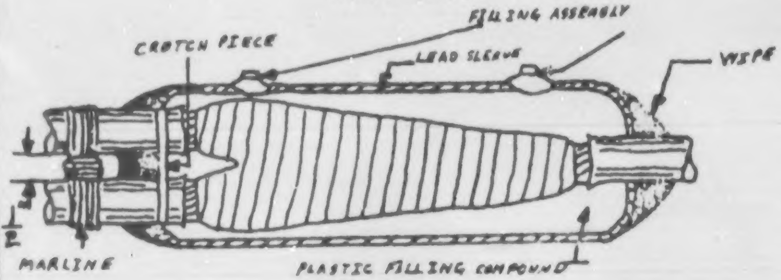
STEP—No.3


OVERLAP 1" AND PRESS TOGETHER FOR ENTIRE LENGTH.
PRESS TOGETHER IN CROTCH
RUBBER INSULATING PAD OR

SECTION A—A


1"/4
3"/4 OZONE-RESISTANT RUBBER TAPE, HALF-LAP
1"/4
FRICTION TAPE-2 LAYERS, HALF LAP
5"/16 MINIMUM THICKNESS

STEP—No.4


FILLING ASSEMBLY
CROTCH PIECE
LEAD SLEEVE
WIPE
1/2
MARLINE
PLASTIC FILLING COMPOUND

STEP—No.5

Supersedes Pg. 2 of Spec. E-92-31 and
DWG. OP 2816-1.

BRANCH JOINT

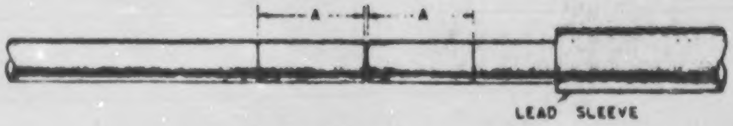
RUBBER-INSULATED LEAD-COVERED CABLE

5,000 VOLTS

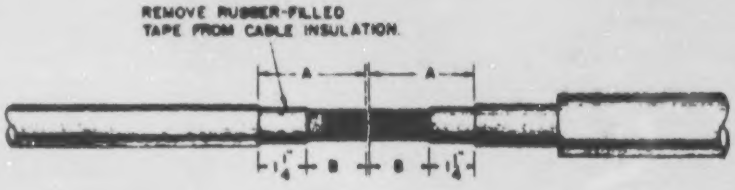
Consolidated Edison Company of N.Y. ...
Electrical Engineering Department
Outside Plant Bureau

Date 3-26-38	DWG. No. [illegible] 1127-C
Last Rev. 8-7-41	

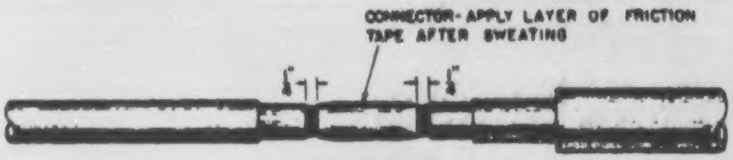
490


A
A
LEAD SLEEVE

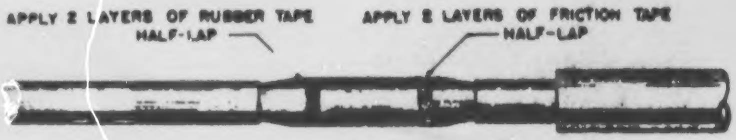
STEP NO 1


REMOVE RUBBER-FILLED TAPE FROM CABLE INSULATION.
A
A
1 1/4"
B
B
1 1/4"

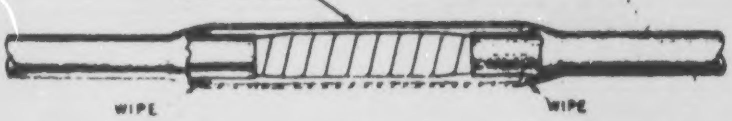
STEP NO 2


CONNECTOR-APPLY LAYER OF FRICTION TAPE AFTER SWEATING
1/4"
1/4"

STEP NO 3


APPLY 2 LAYERS OF RUBBER TAPE HALF-LAP
APPLY 2 LAYERS OF FRICTION TAPE HALF-LAP

STEP NO 4


LEAD SLEEVE
WIPE
WIPE

STEP NO 5

CODE NO	SIZE OF CONDUCTORS (B&S OR MCM)	DIMENSIONS (INCHES)				
		LEAD SLEEVE		CONNECTOR LENGTH	A	B
		I D	LENGTH			
S-1	6 TO 6	1	6	1 1/2	2 1/4	1
S-2	2 TO 6	1	7	2	2 1/2	1 1/4
S-3	2 TO 2	1	7	2	2 1/2	1 1/4
S-4	2/0 TO 6	1	7	2	2 1/2	1 1/4
S-5	2/0 TO 2	1	7	2	2 1/2	1 1/4
S-6	2/0 TO 2/0	1	7	2	2 1/2	1 1/4
S-7	4/0 TO 6	1 1/2	8	2 1/2	2 3/4	1 1/2
S-8	4/0 TO 2	1 1/2	8	2 1/2	2 3/4	1 1/2
S-9	4/0 TO 2/0	1 1/2	8	2 1/2	2 3/4	1 1/2
S-10	4/0 TO 4/0	1 1/2	8	2 1/2	2 3/4	1 1/2
S-11	350 TO 6	1 1/2	8	2 1/2	2 3/4	1 1/2
S-12	350 TO 2	1 1/2	8	2 1/2	2 3/4	1 1/2
S-13	350 TO 2/0	1 1/2	8	2 1/2	2 3/4	1 1/2
S-14	350 TO 4/0	1 1/2	8	2 1/2	2 3/4	1 1/2
S-15	350 TO 350	1 1/2	8	2 1/2	2 3/4	1 1/2
S-16	500 TO 4/0	1 1/2	8	3	3	1 3/4
S-17	500 TO 350	1 1/2	8	3	3	1 3/4
S-18	500 TO 500	1 1/2	8	3	3	1 3/4
S-19	750 TO 350	2	9	3 1/2	3 1/4	2
S-20	750 TO 500	2	9	3 1/2	3 1/4	2
S-21	750 TO 750	2	9	3 1/2	3 1/4	2

SUPERSEDES: N.Y. EDISON CO. DWG. NO. 14290

STRAIGHT JOINT
RUBBER-INSULATED LEAD-COVERED CABL
SECONDARY MAINS & SERVICES
120-240 VOLTS

CONSOLIDATED EDISON COMPANY of N. Y., I
ELECTRICAL ENGINEERING DEPARTMENT
OUTSIDE PLANT BUREAU

DATE 2-8-40
DWG. EO-2676-C REV

634

NOTE: SEE BILL OF MATERIAL ON REVERSE SIDE.

onsolida Edison Company of N Y Inc

Electrical En[illegible]ering Dep
Outside Plant Bureau
July 21, 1941

Bill of Materials
for
Standard Straight Joint
Rubber-Insulated Lead-Covered Cable
Secondary Mains and Services
120-240 Volts
Dwg. No. EO-2675-C Rev. 0

Item	Spec. or Dwg. No.	Unit	Code No.	S-1	S-2 to S-6 Incl.	S-7 to S-18 Incl.	S-19 S-21
					Quantities for 2 Joints		
onnector - Size to Fit Cable	FB-10016	Each		2	2	2	2
ead Sleeve - Plain (Size in inches)	EO-6009	Each		2 (1 x 6)	2 (1 x 7)	2 (1½ x 8)	2 (2
older - Grade A, 40-60 Tin Lead	EO-100,052	Pound		1	1	2	4
ubber Tape - 3/4" Wide	EO-6013	Roll		1	1	1	2
riction Tape - 3/4" Wide	EO-6012	Roll		1	1	1	1
aste Cloth	-	Pound		1/2	1/2	1/2	1/2
aper Pasters - 2½" x 12" Strip	E-54-30	Each		4	4	4	6
tearine Flux	-	2 Oz. Stick		1	1	1	1
					Quantities for 3 Joints		
onnector - Size to Fit Cable	FB-10016	Each		3	3	3	3
ead Sleeve - Plain (Size in inches)	EO-6009	Each		3 (1 x 6)	3 (1 x 7)	3 (1½ x 8)	3 (2 x
older - Grade A, 40-60 Tin Lead	EO-100,052	Pound		1	1	3	6
ubber Tape - 3/4" Wide	EO-6013	Roll		1	1	1	3
riction Tape - 3/4" Wide	EO-6012	Roll		1	1	1	1
aste Cloth	-	Pound		1/2	1/2	1/2	1/2
aper Pasters - 2½" x 12" Strips	E-54-30	Each		6	6	6	9
tearine Flux	-	2 Oz. Stick		1	1	1	1

635

636 164

nsolidated Edison Company of N Y Inc.

Electrical Engineering Department
Outside Plant Bur
July 21, 1941

492

Bill of Materials
for
Standard Straight Joint
Rubber-Insulated Lead-Covered Cable
Secondary Mains and Services
120-240 Volts
Dwg. No. EO-2675-C Rev. 0

Item	Spec. or Dwg. No.	Unit	Code No.	S-1	S-2 to S-6 Incl.	S-7 to S-21 Incl.	S-19 to S-21 Incl.
					Quantities for 2 Joints		
nector-Size to Fit Cable	PB-10016	Each		2	2	2	2
d Sleeve-Plain (Size in inches)	EO-6009	Each		2 (1X6)	2 (1X7)	2 (1½X8)	2 (2X9)
der-Grade A, 40-60 Tin Lead	EO-100,052	Pound		1	1	2	4
ber Tape-3/4" Wide	EO-6013	Roll		1	1	1	2
ction Tape-3/4" Wide	EO-6012	Roll		1	1	1	1
te Cloth	-	Pound		1/2	1/2	1/[illegible]	1/2
er Pasters-2½" X 12" Strip	E-54-30	Each		4	4	4	6
arine Flux	-	2 Oz. Stick		1	1	1	1
					Quantities for 3 Joints		
nector-Size to Fit Cable	PB-10016	Each		3	3	3	3
d Sleeve-Plain (Size in inches)	EO-6009	Each		3 (1X6)	3 (1X7)	3 (1½X8)	3 (2X9)
der-Grade A, 40-60 Tin Lead	EO-100,052	Pound		1	1	3	6
ber Tape-3/4" Wide	EO-6013	Roll		1	1	1	3
ction Tape-3/4" Wide	EO-6012	Roll		1	1	1	1
te Cloth	-	Pound		1/2	1/2	1/2	1/2
er Pasters-2½" X 12" Strips	E-54-30	Each		6	6	6	9
arine Flux	-	2 Oz. Stick		1	1	1	1

638

637

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.3.1J

(TITLE) 5 KV SINGLE CONDUCTOR CAPNUT POTHEAD

INTRODUCTION:

The terminating procedures outlined in this job sheet are recommended by "G & W Electric Specialty Company" for termination of single conductor cables using their #GWI-1-56 Type "T" capnut pothead. Splicing instructions and catalog are available through the G & W Electric Specialty Company.

Read the entire job sheet before starting work; then turn to the first page of splicing instructions and begin splicing. Follow the proper steps of procedure and observe all safety precautions which apply to your job.

REFERENCE

Underground Systems Reference Book, 1957 Edition, Edison Electric Institute

EQUIPMENT AND MATERIALS

1. Shoemaker's knife
2. Six (6) foot wooden folding rule
3. Safety goggles
4. Splicers cotton gloves (long wrislet)
5. Compound temperometer
6. Wiping cloth 2" X 2" or 3" X 3"
7. File and handle
8. File cleaning brush
9. Cableman's saw and guard
10. Pliers
    a. Lineman's
    b. Diagonal-cutting
    c. Channel-locks
11. Steel tool box
12. Terminal lug (the correct size required of either the below):
    a. Solder-sweated split-tinned type
    b. Compression type
13. Tapes (type required)
    a. Ozone resistant rubber Scotch #23 or equal
    b. Plastic scotch #33 plus or equal
    c. Cotton tape, one-half inch
    d. Varnished-cambric
14. Abrasive cloth (non-conducting)
15. Solder 40/60

JOB SHEET 1.3.3.1J (continued)

16. Stearine candles
17. Wiping rags (lint-free preferred)
18. Scotchkote (or equal) rubber cement
19. Cleaning agent (an approved type) such as white gas, naphtha, etc.
20. Neoprene jacketing tape (if required) Bishop Co. Bi-prene or equal
21. Anydrous tape scotch #P-4 restricting tape (or equal)
22. P&B joint covering paint
23. G&W Novoid compound
24. Cast iron solder pot (or electric)
25. Tool pan
26. Solder catch pan
27. Solder ladles
28. Cable cutters, hand
29. Connector compression tool (Burndy)
30. Gas furnace - (type available)
31. Folding wind shield
32. Pot hook handle

JOB STEPS

1. Prepare cable.

    a. Arrange the cable into the desired final position.

    b. Prepare cable as shown in manufacturer's instruction for #GWI 1-56, Single Conductor, Type T Capnut Pothead.

2. Preparation of lead sleeve.

    a. Cut wiping sleeve on gauge lines to pass cable.

    b. Remove any burrs or sharp edges.

3. Pothead

    a. Mount pothead on the supporting structure

    b. Form cable to the approximate final position.

    c. Mark sheath even with the lower end of the porcelain insulator and the lower end of the wiping sleeve.

    d. Remove wiping sleeve from the lower end of the pothead and slide down over the cable.

    e. Measure the distance from the bottom of the cable socket to the lower end of the porcelain insulator.

f. Cut the cable at this measured distance above the top mark on the sheath.

g. Remove the sheath and the cable insulation at the end of the cable for a distance equal to the depth of the cable socket, plus 1/2 inch.

NOTE: Be careful not to open up the conductor strands.

h. Remove cable socket stud from porcelain insulator.

i. Tin the end of the conductor and socket of the connector and sweat together.

4. Removing the lead sheath.

a. Remove the lead sheath from the cable down to 1" above the lower mark on the sheath.

b. Bell the end of the lead sheath slightly by properly scoring and tearing.

NOTE: Be careful not to injure the factory insulation of the cable.

c. Wrap .005" X ½" copper shim around the cable insulation and slide it 3/16" under the lead sheath.

d. Pencil the insulation at the cable socket for ½".

e. Tape end of the cable with varnished-cambric to prevent the insulation from loosening.

5. Stress cone.

a. Build up the insulation for the stress cone of half-lapped 3/4" or 1" oil-packed varnished-cambric tape to approximately 1/8" thickness.

b. Over the cone of varnished-cambric tape apply 3/4" wide copper mesh tape with one-half lap extending from the largest diameter of the cone to the cable sheath.

c. Spot solder the copper mesh tape at different points along the cone and to the cable sheath.

6. Final preparation.

496

JOB SHEET 1.3.3.1J (continued)

a. Paint entire surface of the wiping sleeve gasket with a good grade of gasket compound and after allowing it to become tacky, place it over the cable and into the machined groove of the wiping sleeve.

b. Clean and dry the inside of the porcelain insulator and place it over the cable socket and cable.

NOTE: Insure that the locking fins on the cable socket connector are properly located to engage in the slots in the porcelain.

c. Bolt the porcelain insulator tightly to the wiping sleeve. Insure that the filling plug is in a convenient location. Tighten all bolts evenly.

d. Use a wire brush on the threads of the stud to remove any foreign particles of dirt and then assemble the top seal as follows:

(1) Paint the entire surface of the top sealing gasket with a good grade of gasket compound.

(2) Allow the gasket to become tacky, then place it in the machined groove of the capnut.

(3) Screw the capnut down on the stud until there is no space between the bottom of the capnut and the top of the porcelain bushing.

e. Screw the venting and stud positioning plug and gasket into the hole in the side of the capnut.

NOTE: If the plug does not go all the way in, the cable has been cut too long. The pothead must be taken apart and corrections made.

f. Use stearine as a flux and wipe the joint between the wiping sleeve and the lead sleeve of the cable.

NOTE: Remove wiping sleeve pipe plug during this operation to eliminate the internal pressure.

g. Attach the standpipe to the filling hole. The standpipe should be heated before pouring the oil through it. Fill until the oil comes out of the top vent hole. Allow time for the oil to cool, then remove the standpipe. Coat the thread of the filling and vent plugs with gasket compound and tighten securely.

h. Retighten all joints securely. Brighten contact surface on the capnut stud with sandpaper and attach aerial lug.

INSTRUCTOR'S INITIALS ______

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.4.1J

(TITLE) ALL-TAPE SPLICE KIT

INTRODUCTION:

This job sheet is designed for your use and it provides the necessary information that is needed to complete the assigned splice. Before you proceed read the entire job sheet and any instructions that may be included with the kit.

Before starting work, see that the uni-kit, the tools and materials are all at the site of installation. Once the splicing has begun, it should be continuous and as rapid as good workmanship will allow. Follow the proper steps of procedure and observe all safety precautions which apply to your job.

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Hacksaw
3. Sharpening stone
4. Soldering coppers
5. Compression tools, Burndy
   a. Hytool MY29-3
   b. Hypress Y34A (hydraulic)
   c. Hypress Y35 (hydraulic)
6. Cable stripping tools, PLM type SQ, various sizes
7. Cable penciling tools, PLM type PT, various sizes
8. Cable slicer
9. XLP shielded, 1/C, AWG #4/0
10. GE Uni-Kit No. SS 8-B or equal

JOB SHEET 1.3.4.1J (continued)

11. Connectors

    a. Burndy Hylink YS28

    b. T&B 5412 (4/0)

JOB STEPS

1. Prepare cables

    a. Train cables into final position and cut to proper length so that cable ends will butt squarely.

    b. Remove cable jacket and any underlying non-metallic tapes for the distance recommended for the kit (SS-8-B), which is 10 inches. Be careful not to nick the underlying mettalic shielding tape.

    c. Carefully cut and remove the metallic shielding tape or tapes to within 1½ inches of the jacket. (Both cables). Be careful not to damage the underlying semi-conducting tape. Place a solder tack at the cut end of the shielding tape where it laps itself. Use minimum heat.

    d. Carefully cut and remove the semi-conducting tape or tapes to ½-inch from the edge of the metallic shielding tape. Without slitting the semi-conducting tape, fold the exposed ½-inch back onto the metallic shielding tape. Be careful not to damage the insulation under the semi-conducting tape or disturb the semi-conducting tape under the metallic tape.

    e. Carefully remove the insulation and semi-conducting strand shielding from the end of the conductor so that 3/4-inch of bare conductor is exposed after the connector is in place. (Half the connector length plus 3/4-inch.) Be careful not to nick the conductor.

    f. Using a sharp knife or penciling tool, smoothly taper the insulation at each cable end for a distance of 1 inch. Use the abrasive cloth to buff the taper into a smooth surface without edges. Again use care not to nick the conductor.

2. Connector Installation

    a. Apply the connector. An E.E.I. approved solder type connector is preferred.

(1) Connectors (either a Burndy Hylink YS28 or T&B 54512, 4/0).

(2) Use minimum heat with extreme care not to melt the tapered insulation. Allow connector to cool before proceeding to next step.

b. Thoroughly and carefully clean all of the exposed insulation with the abrasive cloth, removing all traces of conducting material. Finish cleaning the insulation and connector with the solvent-dampened cloth. Allow solvent to dry thoroughly before continuing to next step.

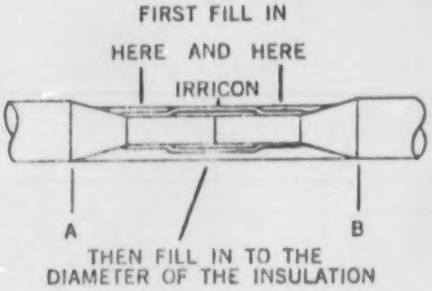
c. Always be sure to remove the backing from all tapes, as they are applied. Using slight tension, wrap one half-lapped layer of Irricon S-B Conducting tape completely over the conductor and connector surface. In this operation, the conducting tape should overlap the bottom edge of each insulation taper - but not more than 1/16 inch. Make sure that the edges of the conducting tape are even where it meets the cable insulation. This is done by making one full, even turn (NOT HALF-LAPPED) at the beginning and end of the taping operation.

d. In cases where the diameter of the connector and its wrapping of conducting tape is less than the cable insulation diameter, fill the connector area from A to B (see diagram below) with 3/4 inch 8380 tape as follows:

(1) Fill in one conductor area to the diameter of the tape over the connector (do not cut tape).

(2) Half-lap the tape across the connector, and,

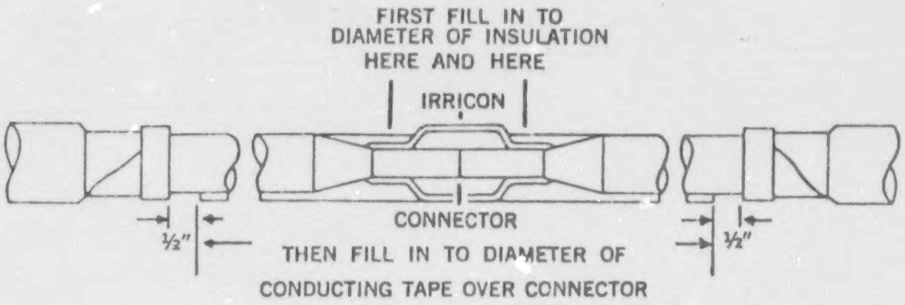
(3) Fill in the other conductor area to the same siameter. When the tape build up is level across the entire area, begin half-lapping back and forth evenly, filling in the area from A to B up to the level of the insulation.



e. In cases where the diameter of the connector and its wrapping of conducting tape is equal to or greater than the insulation diameter, fill in the area between the connector and the top of the taper with 3/4-inch 8380 tape as follows:

(1) Build up the areas on both sides of the connector to the diameter of the insulation.

(2) Now, half-lap the 8380 tape back and forth from the connector to a point ½-inch from the folded edge of the semi-conducting tapes of each cable until you achieve a continuous even diameter across the splice. Do not build up this diameter any larger than necessary. (see diagram below).

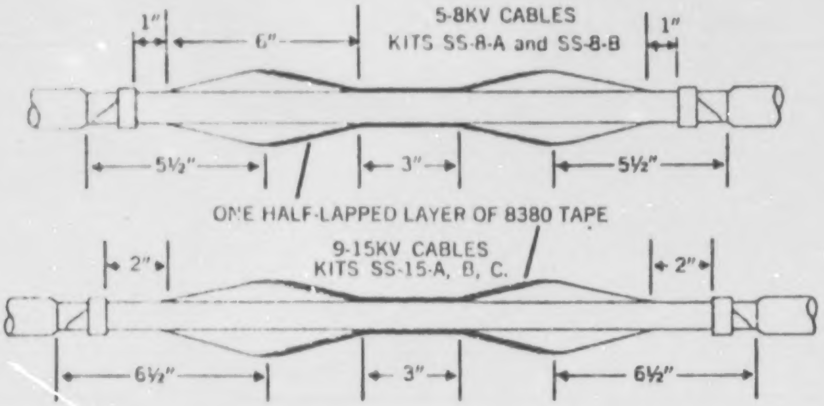


3. Replacing Insulation.

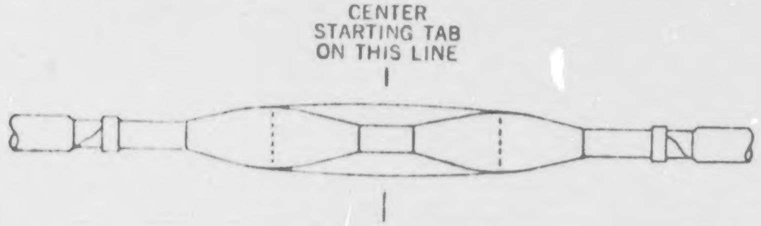
a. There are three preshaped stress cones in each splic kit. Two of them are identical. Peel the backing from the starting tab of one of two identical stress cones for a distance of approximately 6 inches. Center the starting tab against the cable insulation on one cable at a distance from the cable jacket of 5½ inches. Tightly wrap the preshaped stress cone with sufficient tension to assure a smooth wrinkle free surface on each layer. When the widest part of the cone is on the cable, check to be sure it fits tightly to the surface. Finish wrapping the remaining layers. The preshaped stress cone is designed so that each layer will center itself on the previous layer if wrapping is done smoothly with no wrinkles.

b. In the same manner as in Step a., wrap the second identical stress cone on the other cable insulation. Note that there will be a gap between the stress cones of approximately 3 inches or more for all kits.

c. From the peak of one of the stress cones, tightly wrap one half-lapped layer of 1 inch 8380 tape across the mid point of the splice to the peak of the other pennant. Use maximum tension.

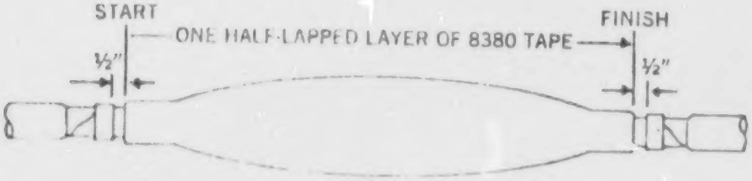

5-8KV CABLES
KITS SS-8-A and SS-8-B
1"
6"
1"
5½"
3"
5½"
ONE HALF-LAPPED LAYER OF 8380 TAPE
9-15KV CABLES
KITS SS-15-A, B, C.
2"
2"
6½"
3"
6½"

d. Peel the backing from the starting tab of the last preshaped stress cone for a distance of about 6 inches. Center the starting tab of this stress cone at the mid point of the splice between the two stress cones previously applied. Wrap this stress cone in the same manner as the other two. Take care that this center stress cone builds up evenly on each of the side stress cones as it is wrapped.


CENTER
STARTING TAB
ON THIS LINE

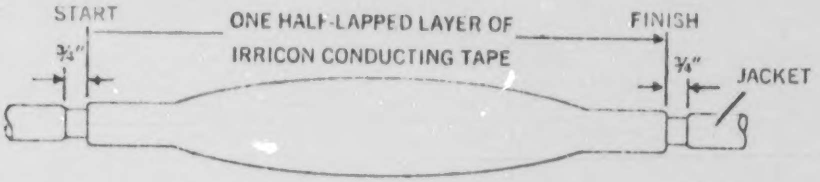
e. Tightly wrap the splice with one half-lapped layer of 1-inch 8380 tape as follows:

(1) Starting on the insulation of one cable, ½-inch from the shield, wrap across the splice to the insulation ½-inch from the shield of other cable.

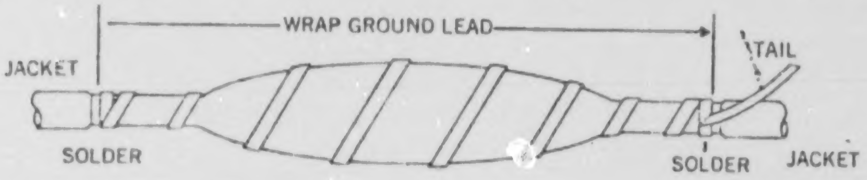

START
ONE HALF-LAPPED LAYER OF 8380 TAPE
FINISH
½"
½"

f. Wrap one half-lapped layer of Irricon S-B conducting tape between the two cable shields as follows:

(1) Starting on one of the metallic shielding tapes, 3/4-inch from the edge of the cable jacket, carefully half-lap across the splice onto the other shielding tape 3/4-inch from that cable's jacket. Be sure to leave enough room to solder ground lead on each shield. This conducting tape will overlap the folded semi-conducting tape folded back in step 1.d.



g. Solder one end of the tinned copper ground lead to one of the exposed copper shielding tapes (use minimum heat). Spiral this ground lead around the splice (over the conducting tape). Be sure it lays flat. There should be roughly 1½ inches between spirals. Now, wrap the lead around the opposite exposed copper shield and solder. A two (2) or three (3) foot "tail" of the lead should remain. DO NOT CUT.

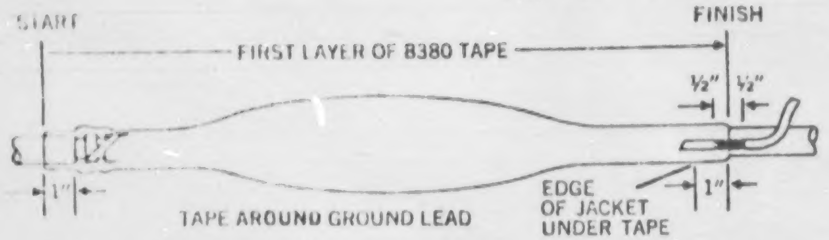


4. Shielding and covering the splice.

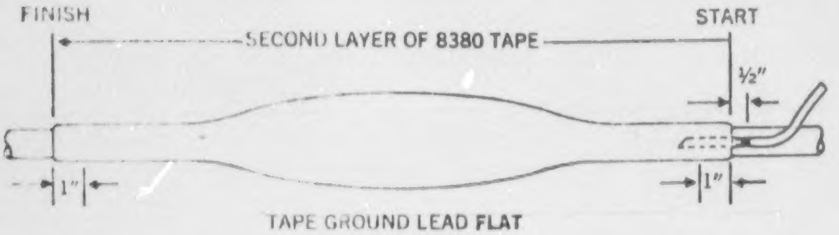
a. (Read this step through before starting). Cover the entire splice with two half-lapped layers of 1 inch 8380 tape as follows:

(1) Start the tape 1-inch on the cable jacket on the opposite side of the splice from the ground lead "tail". Half-lap across the splice and 1 inch onto that cable's jacket. Tape tightly around the point of attachment of the ground lead "tail".

(2) Now, fold the "tail" flat against the side of the cable and fill it with solder for ½-inch on each side of the point where it passes over the edge of the 8380 tape


START
FINISH
FIRST LAYER OF 8380 TAPE
½"
½"
1"
1"
EDGE OF JACKET UNDER TAPE
TAPE AROUND GROUND LEAD

(2) Now, tightly half-lap the second layer of 8380 tape back to the starting point. Wrap over the ground lead on this layer. The solder filled area should be approximately half covered with tape.

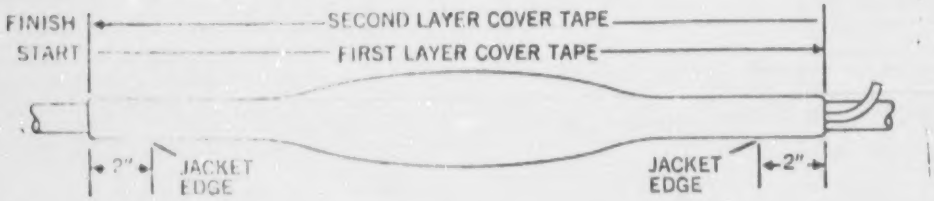

FINISH
START
SECOND LAYER OF 8380 TAPE
½"
1"
1"
TAPE GROUND LEAD FLAT

b. Cover all tapes previously applied with two half-lapped layers of vinyl cover tape as follows:

(1) Start 2 inches on one cable jacket, tightly wrap across the splice 2 inches onto the opposite cable jacket.

(2) Tape the ground lead "tail" flat against side of cable.

(3) Now, wrap tightly back to the starting point.


FINISH
START
SECOND LAYER COVER TAPE
FIRST LAYER COVER TAPE
2"
JACKET EDGE
JACKET EDGE
2"

REFERENCES:

1. Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th Street, Cleveland, Ohio 44135, Chapter III, IV and V.

2. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 2.15, 18, 29 and 9-43.

3. Design and Engineering Manual, 3M Electro-Products Division.

INSTRUCTOR'S INITIALS ___________

504

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.4.2J

(TITLE) 3M "SCOTCHCAST" PRINT E-MPD-3

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete the assigned splice. Before you proceed read the entire job sheet and any instructions that may be included with the kit.

Once the splicing has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of insulation to the atmosphere.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Hacksaw
3. Sharpening stone
4. Soldering coppers
5. Compression tools, Burndy
    a. Hytool MY29-3
    b. Hypress Y34A (hydraulic)
    c. Hypress Y35 (hydraulic)
6. Cable stripping tools, PLM type SQ, various sizes
7. Cable penciling tools, PLM type PT, various sizes
8. Cable slicer
9. Resin pressure gun, Scotchcast E-4A
10. Cable, XLP shielded, 1/C, AWG #4/0

650

JOB SHEET 1.3.4.2J (continued)

11. Connectors
    - a. Burndy Hylink YS28 or T & B 54512 (4/C)
    - b. Burndy Hylink YS 26 or T & B 54510 (2/0)
12. Tape
    - a. Shielding braid, Scotch 24, Tomic No. 15T
    - b. Spacer, Scotch No. P-3, 9G 5975 00909 2053
    - c. Anhydrious, Scotch No. P-4
    - d. Vinyl plastic, 1" X 108', Scotch #88 - 9G 5970 00926 7220
13. Injection fitting "Scotchcast" P-1 - 9G 5975 00992 3589
14. Nozzle for E4 Resin pressure gun, P-5 - 9G 5975 00992 3590
15. Resin, "Scotchcast" electrical insulating, No. 4, sizes "B" & "C" - 9G 5970 00814 1788
16. Abrasive paper, Grit 320, 9G 5350-00229-3086
17. Solder, wire SN-50 - 3439 273 1637
18. Trichlorethylene

JOB STEPS

Perform Job Steps as outlined in Design and Engineering Manual for splicing and terminating power cable, 3M Electro-Products Division, Minnesota Mining and Manufacturing Company.

REFERENCES

1. Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th Street, Cleveland, Ohio 44135, Chapter III, IV, and V.
2. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 2.15, 18, 29, and 9-43.

INSTRUCTOR'S INITIALS ____________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.4.3J

(TITLE) "Collyer" Print No. SR-4; Mine Power Cable 5-15 kv, Straight Splice (Shielded) 3/C

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete the assigned splice. Before you proceed read the entire job sheet and any instructions that may be included with the kit.

Once the splicing has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of insulation to the atmosphere.

Satisfactory cable joints are largely dependent upon the quality of workmanship, therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

REFERENCES

1. Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th Street, Cleveland, Ohio 44135, Chapter III, IV, and V.

2. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 2-15, 18, 29, and 9-43.

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Hacksaw
3. Sharpening stone
4. Soldering coppers
5. Compression tools, Burndy
    a. Hytool MY29-3
    b. Hypress Y34A (hydraulic)
    c. Hypress Y35 (hydraulic)

JOB SHEET 1.3.4.3J (continued)

6. Cable stripping tools, PLM type SQ, various sizes

7. Cable penciling tools, PLM type PT, various sizes

8. Cable slicer

9. Cable. XLP shielded, 3/C, AWG 2/0 or 4/0

10. Connector - Burndy Hylink YS26 or T & B 54510 (2/0)

11. Tape

    a. Semi-conducting, "Scotch" 13 or equal

    b. High voltage, "Scotch 23, GE 8380, Bishop Bi-seal (Tomic No. 3T) 9G 5970 00931 4491

    c. Shielding braid, Scotch 24, Tomic No. 15T

    d. Vinyl plastic, 1" X 108', "Scotch" #88 - 9G 5970 00926 7220

12. Abrasive paper, Grit 320, 9G 5350 00229 3086

13. Solder, Wire SN-50 - 9G 3439 273 1637

14. Trichlorethylene

JOB STEPS

Perform Job Steps as outlined in Collyer (Mine Power Cable 5-15KV) Straight Splice Instructions, Collyer Insulated Wire Company, Lincoln, R. I.

INSTRUCTOR'S INITIALS ____________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.5.1J

(TITLE) "SCOTCH" K TAPE TERMINATION KITS

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete the assigned splice. Before you proceed read the entire job sheet and any instructions that may be included with the kit.

Once the splicing has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of insulation to the atmosphere.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

REFERENCES

1. Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th Street, Cleveland, Ohio 44135, Chapter III, IV, and V.

2. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Chapter 9, Sec D.

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Hacksaw
3. Sharpening stone
4. Soldering coppers
5. Compression tool
6. Cable stripping tool
7. Cable pencilling tool
8. Cable slicer

509

JOB SHEET 1.3.5.10 (continued)

9. Cable, XLP, 5 kv, shielded, AWG 4/0

10. 3M Co. "K" tape termination kit

11. Lug, Burndy YA28, AWG 4/0

12. Solder, wire SN-50

JOB STEPS

Perform Job Steps as outlined in Scotch K Tape Termination Kits Instruction, 3M Company, Electro-Products Division, Saint Paul, Minnesota 55101.

INSTRUCTOR'S INITIALS ______________

510

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.6.1J

(TITLE) STRAIGHT TRANSITION SPLICE W/OIL STOP, 5 KV, 1/C, XLP TO VCL

INTRODUCTION

This job sheet is designed to be used by you for actual step-by-step procedures to make a straight joint between lead-covered and non-lead-covered cables. Application of these procedures, step-by-step is absolutely essential to insure that your splice meets the standards required to produce a trouble-free joint. READ the reference material, the entire job sheet and then begin the job steps.

REFERENCE

Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, Pages 9-13 through 9-18

EQUIPMENT AND MATERIALS

1. Cable Splicers Tool Box
2. Hacksaw
3. Cable stripper
4. Cable Penciling Tool
5. Soldering Copper
6. Compound Kettle
7. Butane Furnace
8. Sharpening Stone
9. Lead covered cable, VCL, 3' length
10. Non-lead covered cable, XLP 3' length
11. Connector, copper-split-tinned
12. Sleeve, lead
13. Sleeve, lead-auxiliary (5")
14. Insulating Varnish (Glyptal-Aerisol
15. Tapes
    a. 1/4" "Fibermat", dry
    b. 1/4" Varnished cambric or Polyester, oil immersed
    c. 1/2" " " " " " "
    d. 3/4" " " " " " "
    e. 3/4" " " " " dry
    f. Copper Mesh Tape, 1"
    g. 1/2" Cotton Tape
    h. Paper paster, 2"
    i. 3/4" Rubber tape (when necessary f/step 10)
    j. 3/4" Friction tape
    k. 3/4" Vinyl tape

JOB SHEET 1.3.6.1J (continued)

16. Filling Compound
17. Non-conductive abrasive cloth
18. Trichlorethylene (TCE), w/lint free cloth
19. Solder (wire 50-50)
20. Solder, wiping (40-60)

JOB STEPS

1. Insure that you have all necessary tools and materials as listed in this job sheet.

2. Train and cut cables.

   a. Train cables to desired final position allowing an overlap of cables.

   CAUTION: AVOID SEVERE BENDING. ALWAYS ABIDE BY THE MANUFACTURER'S MINIMUM BENDING RADIUS.

   b. Cut cables to butt squarely at the desired centerline of splice (joint).

   NOTE: THE CABLE ON ONE SIDE OF THE CENTERLINE MUST BE STRAIGHT ENOUGH FOR THE LEAD SLEEVE TO SLIDE OVER IT OR YOU WILL HAVE TO SPLIT AND OPEN YOUR SLEEVE TO PLACE OVER SPLICE (JOINT).

3. Prepare the lead sleeve.

   a. Clean both ends of sleeve for three to four inches by scraping with a shave hook brushing with a file cleaner brush.

   b. Apply sterine flux to cleaned portion of the sleeve.

   c. Beat down one end of sleeve to fit the lead covered cable. Use a cable dresser.

   d. Slide sleeve on the lead covered cable back out of the way of the joint.

4. Tinning and removing the lead sheath.

   a. Mark the lead sheath at 6" plus ½ the length of the connector plus ½".

   b. Ring the sheath at the mark with a sheath knife and tinners hammer.

JOB SHEET 1.3.6.13 (continued)

CAUTION: RING SHOULD BE APPROXIMATELY ONE-HALF THROUGH THE LEAD SHEATH. "DO NOT DAMAGE THE INSULATION"

c. Clean the lead sheath for 3" beyond the ring with a shave hook or file cleaner brush and apply stearine flux.

d. Apply paper pasters on ends of cleaned area so as to have 2½" of exposed cleaned cable sheath. The first paster should cover the ring plus ½" of the cleaned portion.

e. Tin cleaned portion of the cable sheath with wiping solder using correct procedures.

f. Remove paper pasters.

g. Slit the sheath from end to the ring using the sheath knife and tinners hammer using correct procedures.

h. Remove the lead sheath by opening with the sheath opener and with a twisting motion leave a natural bell on the remaining sheath.

CAUTION: DO NOT LEAVE ANY SHARP POINTS ON EDGES OF THE SHEATH.

5. Remove jacket on rubber or plastic insulated cable.

   a. Remove 7" of jacket by ringing and splitting with shoemaker's knife.

CAUTION: DO NOT DAMAGE OR NICK INSULATION.

6. Remove metallic shield from the cable leaving 1" of shield from the jacket.

7. Remove the semi-conducting material to ½" from the shielding.

CAUTION: ALL SEMI-CONDUCTING MATERIAL MUST BE REMOVED FROM THE INSULATION TO PREVENT YOUR SPLICE FROM BREAKING DOWN UNDER LOAD.

8. Pencil the jacket end ¼" using a sharp knife.

9. Clean and tin a 5" auxiliary sleeve using correct procedures.

10. Tightly fit the auxiliary sleeve over the cable end. It may be necessary to build up cable with rubber tape.

11. Apply copper mesh tape from the metallic shielding on to the auxiliary sleeve.

JOB SHEET 1.3.6.1J (continued)

a. Half-lap the copper mesh tape.

b. Spot solder the shielding tape to the auxiliary sleeve and to the metallic shielding using a hot soldering iron and 50-50 solder.

CAUTION: DO NOT OVERHEAT INSULATION AS IT WILL CAUSE FAILURE OF THE SPLICE.

12. Prepare cable ends for the connector.

a. Mark ends one half the length of the connector plus ½".

b. To prevent the varnish cambric factory insulation from unwinding wrap with dry varnished cambric tape and tie off at sheath end.

c. Cut the insulation squarely down to the conductor with shoemakers knife or taper knife at the mark.

CAUTION: DO NOT NICK THE CONDUCTOR.

d. Pencil the insulation for a distance of 3/4" using correct procedures.

13. Installing Connector

a. Polish exposed conductors and connector thoroughly using non-conducting abrasive cloth. Wipe with a lint free cloth and solvent.

b. Fit ends of conductors squarely in the center of the connector. Provide small gap between conductors for oil-stop.

c. Crimp, solder and polish connector.

14. Preparation of splice (joint) for insulating.

a. Using non-conducting abrasive cloth roughen and clean the insulation on the non-lead covered cable, then wipe with lint free cloth and solvent.

b. Remove the dry varnished cambric tape and one layer of factory insulation from the lead sheath covered cable.

NOTE: THIS WILL ELIMINATE ANY FOREIGN MATERIAL THAT MAY HAVE ACCUMULATED ON THE INSULATION.

15. Insulating the splice (joint).

JOB SHEET 1.3.6.1J (continued)

a. Build an oil stop on the non-lead covered cable by starting with a coating of oil stop. Then apply four one-half lapped layers of varnished cambric tape with a coating of lacquer, enamel or oil-stop compound between each layer. The oil stop is to go from the auxiliary sleeve to the center of the connector.

NOTE: ALLOW THE COMPOUND TO DRY BEFORE THE NEXT LAYER OF TAPE IS APPLIED.

b. Fill the space between connector and lead covered cable insulation with 1/4 inch wide oil-immersed varnished cambric tape.

CAUTION: AVOID AIR VOIDS IN YOUR TAPING.

c. Tape over the connector and pencil with ½" oil-immersed varnished cambric tape up to the level of the factory applied insulation.

d. Build up splice with 3/4" oil-immersed varnished cambric tape to two (2) times the factory applied insulation.

NOTE: APPLY TAPE WITH ENOUGH TENSION TO ELIMINATE VOIDS BUT NOT ENOUGH TENSION TO CRACK THE VARNISH ON THE TAPE.

16. Install and wipe lead sleeve.

a. Center the lead sleeve over the splice and beat down the ends tightly on the cable sheath.

b. Apply paper pasters on the sleeves and sheath, wipe joint.

17. Seal the non-lead covered cable end of the sleeve.

a. Apply two (2) one half lapped layers of Ozone resistant rubber tape over the exposed end of the auxiliary sleeve on to the cable jacket to form a water-tight seal. Cover this with vinyl tape.

b. Apply two (2) one-half lapped layers of friction tape over the vinyl tape and apply a protective coat of enamel overall.

18. Filling the splice

a. Make a V-shaped hole at each end of the lead sleeve with the cable sheath knife and tinners hammer.

CAUTION: DO NOT DAMAGE INSULATION

JOB SHEET 1.3.6.10 (continued)

b. Heat the filling compound to the designated pouring temperature on the butane furnace.

c. Fill the splice with compound by pouring in the lower V-shaped hole.

d. Solder the holes closed with 50-50 solder using a soldering copper.

CAUTION: OBSERVE ALL SAFETY PRECAUTIONS WHILE SOLDERING.

19. Prepare the splice for test and hypot

a. Contact the instructor to supervise the test.

b. After the test is complete, disconnect the splice from test leads, and break down the cable and splice.

INSTRUCTOR'S INITIALS ____________

516

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.7.1J

(TITLE) 15 kv, SINGLE CONDUCTOR, VCL CABLE, GROUNDED, BRANCH SPLICE

INTRODUCTION

This job sheet is designed to be used by you for actual step-by-step splicing procedures. Application of these splicing procedures is essential to good trouble free power service. These instructions do not purport to cover all details or variations in equipment nor provide for every contingency to be met in connection with installation, operation or maintenance.

Before starting work, see that the drawing of the joint to be built, the tools, materials and equipment are all at the site of installation. Once the splicing has begun, it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of insulation to the atmosphere. Satisfactory cable splicing is largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials. The cable splicer must also do his best because if he doesn't he may be the one repairing or re-splicing the cable.

Read the entire job sheet first, then, look over all the splice drawings. Turn to the first splice drawing or the drawing you require. Begin by checking for all tools, materials, and equipment required for splicing.

REFERENCE

1. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 9-10 thru 9-22

EQUIPMENT AND MATERIALS

1. Cable splicer's tool box

2. Hacksaw

3. Sharpening stone

4. Pliers, eagle beak

5. Lead sleeve slitter

6. Melting pot (solder)
   a. Electric
   b. Cast iron

652

JOB SHEET 1.3.7.1J (continued)

7. Gas furnace, butane
8. Windshield
9. Cable slicer, hand
10. Oil pot, funnel, & oil pan
11. Cable, 15 kv, VCL, AWG #4/0, 1/C (9' per student)
12. Connector, split tinned, 4/0, branch
13. Tapes
    a. Varnished-cambric, oil immersed, Irvinington 1/2" and 3/4" No. 2511
    b. Varnished Polyester Web Fibermat 1/4" and 3/4" No. 2551
    c. Cotton
    d. Muslin
14. Lead crotch piece (A-1) for branch joint
15. Insulating Oil No. 219
16. Lead sleeve, 3 1/2" X 18"
17. Abrasive cloth (non-conducting)
18. Solder, 40/60 wiping
19. Solder, 50/50 seam
20. Stearine candles
21. Paper pasters
22. Wiping rags

JOB STEPS

1. Cable preparation

   CAUTION: Make sure power cables are not energized before starting work.

JOB SHEET 1.3.7.1J (continued)

- a. Arrange the cables in the desired final position
    - (1) Avoid severe bending
    - (2) Allow slight overlap of ends
- b. Cut splices to butt squarely together at desired centerline of splice.

  NOTE: Slide the sleeve over the splice end having only one cable.

2. Preparation of lead sleeve
    - a. Scrape both ends of the sleeve for 3 or 4 inches with a rasp or shave hook
    - b. Apply stearine flux to cleaned portions
    - c. Beat down one end of the sleeve to slightly larger than cable diameter
    - d. Slide beat down end first over one end of the cable
3. Removing the lead sheath
    - a. Measure and mark the sheath at a distance "A1" and "A2" from cable ends.
    - b. Score the sheath to a depth slightly less than 1/2 of its thickness completely around the cable at these marks using the chipping knife and tinners hammer.
    - c. Scrape the sheath clean on each cable for at least 3 inches beyond the score and apply stearine flux.
    - d. Apply paper pasters on cable ends
        - (1) One to cover the score plus 1/2 inch of the cleaned portion
        - (2) One at opposite end of cleaned area
    - e. Tin cleaned portion of cable sheath

      CAUTION: DO NOT burn through cable sheath
    - f. Remove paper pasters

JOB SHEET 1.3.7.1J (continued)

   g. Slit the sheath up to the score from each end, being careful not to injure the insulation using a chipping knife and tinners hammer

   h. Tear the lead sheath off in such a manner that a natural bell is formed at the end of the sheath

4. Preparation of each end for connector

   a. Apply one layer of dry varnished-cambric tape

   b. Remove insulation and internal shielding tape from each cable end for a distance of one-half (1/2) the length of connector plus one-half inch (1/2) using a sharp knife.

      CAUTION: DO NOT nick the conductor

   c. Protect the ends of the exposed insulation from the heat of soldering by wrapping with a dry cotton tape back to the lead sheath

5. Placing and soldering of connector

   a. Clean the exposed conductor thoroughly and apply stearine flux

   b. Fit the conductor ends into the connector with ends butting firmly in center and with the slot or hole in the connector on top

   c. Hold the assembly in this position and squeeze the connector tightly onto the conductors

      NOTE: The branch cable size should never exceed the size of the main cable. If a branch connector is not available, wrap the branch to the main cable using a #14 AWG tinned copper wire.

   d. Apply heat and solder, making sure that connector and all dents caused by squeezing get filled with solder

   e. Remove excess solder and smooth off all burrs

6. Preparation of splice for insulation

   a. Remove the protective covering from ends of insulation and check for excess solder build up under the cotton tape.

JOB SHEET 1.3.7.1J (continued)

b. Remove the outer layer of factory insulation, to remove dirt particles back to the lead sheath

c. Pencil the insulation or trim

CAUTION: Handle carefully and keep knife sharp, DO NOT nick conductor

d. Wipe clean with a dry cloth the polished surface of the connector and exposed conductor.

NOTE: Make sure that no conducting particles remain on the insulation

e. Boil out the cable with a flushing oil if required to remove dirt and moisture.

7. Insulating the splice

a. Insulate at small diameter areas at end of connector first using 1/4" varnished-cambric tape

NOTE: Fill in crotch area with folded layers of tape or sawdust and petrolatum putty.

b. Apply oil immersed varnish-cambric 3/4" splicing tape, with approximately 50% overlap, to a thickness over the connector of one and one-half (1-1/2) times the factory applied insulation or the thickness required on the drawing (7/16" minimum) and taper down to edge of sheath on each splice end.

NOTE: Tape should be applied with enough tension so that it is not soft or spongy feeling; do not over-stretch the tape and break the varnish coating on the tape.

c. Apply copper mesh tape, half-lap over each conductor as illustrated. Spot solder each end only.

8. Construct and install crotch piece.

9. Closing the splice opening

a. Center lead sleeve over splice

b. Dress down sleeve ends to the cable sheath

NOTE: Ensure lead crotch piece is spot soldered in place between branch conductors and tinned before dressing sleeve ends down. The crotch piece should be one inch (1") from end of lead sheath.

c. Apply paper pasters

(1) One-half inch (1/2") from sleeve on sheath for cables of one inch (1") and under diameter

(2) Three-quarter (3/4) of an inch for cables one inch (1") to three inch (3") diameter on sheath

(3) On sleeve apply at the ridge of sleeve

d. Solder tack sleeve ends then wipe sleeve onto cable sheath

e. Pressure test splice

10. Filling the joint

a. Make two holes in top of the sleeve - each hole to be three inches (3") from end of sleeve and large enough to accommodate the spout of a funnel

b. Fill the sleeve with No. 219 Insulating compound which is heated to the temperature as shown on the label; this temperature should be checked with a temperometer

NOTE: Tilt the joint slightly and fill through the lower hole

c. Level the joint and allow it to stand until it has cooled, and then make a second filling

d. Close and clean the holes and the lead around them, apply stearine flux and paper pasters, then seal the holes carefully with solder.

11. Securing joint and cable

a. Bond cable to other cables and ground

b. Apply corrosion or fire protection (if required)

c. Attach identification tag or mark the cable

INSTRUCTOR'S INITIALS ____________

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET CE "C" 1.3.8.1I

(TITLE) Aluminum Cable and Splices

INTRODUCTION

For many years, annealed copper (tinned or lead alloy coated when used with rubber insulation) was used because of its high conductivity, workability and handling ease. However, aluminum cable has been accepted in many areas and continues to grab an increasing percentage of the cable market.

Techniques in design systems using aluminum conductors are similar to those used with copper. However, due to the lower conductivity of aluminum, a larger size conductor is required (in comparison to copper) to accommodate equivalent electrical loads.

When installing aluminum conductors, trouble-free installations can be expected if a basic knowledge of the material is understood.

REFERENCE

1. Low Voltage, Splicing Manual and Workshop Guide, Electro-Products Division, 3M Company.

2. UD Technical Manual, Cyprus Wire and Cable Company.

INFORMATION

1. Aluminum conductors exhibit three characteristics which must be considered. These are the formation of an aluminum oxide over exposed aluminum surfaces, high creep rate, and its susceptibility to galvanic corrosion.

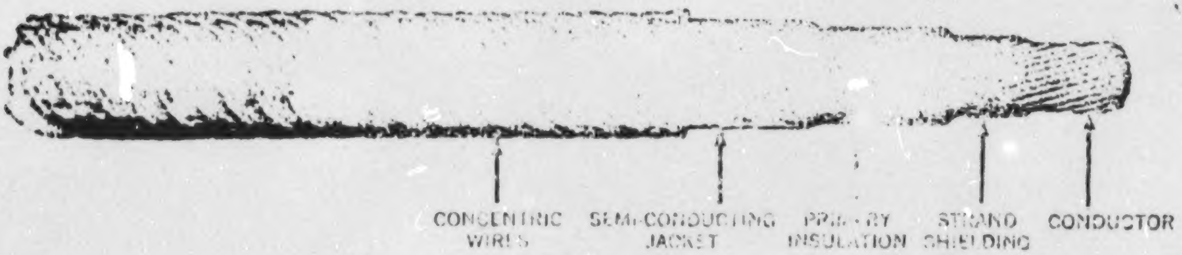
a. Aluminum Oxide. - Aluminum oxide is a very hard film formed over the exposed conductor surface within seconds after the insulation has been removed. This film has a high electrical resistance and acts as an insulator over the conductors and between conductor strands. (This film also gives aluminum wire its excellent anti-corrosion property.) Because of high electrical resistance on exposed conductor surfaces, electrical connections develop an excessive temperature rise. This tendency can be eliminated by the use of "contact aids" (Pentrox, etc.). Contact aids are compounds containing small zinc particles. The particles abrade the oxide film and insure good electrical contact between surfaces. The grease excludes the air, thus preventing reformation of the oxide film.

b. High Creep Rate. - Aluminum is a soft metal and has a high creep rate (cold flow) characteristic. When connectors or terminals are installed, the aluminum has a tendency to physically flow away from the indent or point of compression. This tendency is exaggerated as the temperature rises. Because aluminum expands more rapidly than copper, copper connections or lugs are never used over aluminum conductors. When they are used, after a period of time, the contact pressure will decrease and the resistance of the connection will increase. The aluminum is actually squeezed out of the connectors or lugs with aluminum conductors.

c. Bi-Metallic Corrosion. - (Galvanic Corrosion). The third consideration is corrosion. When aluminum conductors are connected to, or by, other metals and exposed to moisture, the conductor is damaged by galvanic action. Connector manufacturers make tinned copper alloy connectors for aerial connections that eliminate this reaction.

2. Underground distribution (UD) cable selection is essentially the same as that for any other distribution system regarding capability of supplying the connected load without excessive voltage drop or power loss. For underground use, additional requirements must be taken into account, such as the surrounding earth environment together with the dielectric stability and mechanical integrity of the insulating material to insure long cable life and avoid extensive replacement.

a. Single-Phase Primary Cable. - The single-phase primary UD cable design generally accepted as today's standard involves a two-conductor concentric-neutral type construction available for nominal 15 - 35 kv systems. Although the neutral could be installed separately, concentric-neutral in the form of spirally applied #14, 12 or #10 AWG copper wires in sufficient number to provide conductivity in proper proportion to that of the insulated conductor is the best design.



(1) This cable is available with copper or aluminum conductors, although the concentric neutral is always copper.

524

(2) Directly over the conductor, there is provided a thin layer of non-metallic material referred to as "conductor shielding" to which is bonded the insulating material, thus assuring freedom from air-void formation and thereby preventing corona formation under operating voltages at the area of maximum stress.

(3) Power cables operating above 2 kv must incorporate "insulation shielding" to provide protection with respect to safety, electrical voltage stress and lightning. This insulation can be a conducting cross-linked polyethylene.

(3) Over the extruded insulation shield is the concentric-neutral conductor. Some engineers have recognized that in a single-phase that much of the return current flows in the earth rather than in the concentric neutral conductor. Considering this, they have reduced the number and/or size of the concentric neutral wires. The specified neutral conductor must provide adequate mechanical protection to the cable and be able to handle any anticipated short circuit currents.

b. Three-Phase Primary Cable. - The high reliability, economy, and wide acceptance of concentric-neutral single-phase primary cables have led to the usage of three such cables to supply three-phase primary loads.

(1) When a concentric-neutral is operated in single-phase, the magnetic field initiated by the current in the insulated conductor is effectively cancelled outside of the neutral conductor by the magnetic field of the same current flowing in the neutral conductor.

(2) In balanced three-phase circuits using concentric-neutral cable, there is no return current and, hence, cancellation of the magnetic field outside of the concentric-neutral is not effected.

(3) Thermal considerations must be considered as circulating currents can flow in these shorted wires, and heat will be realized from (I^2R) loss.

(4) One way to eliminate circulating currents in the concentric-neutral for a three-phase circuit is to jacket (further insulate) the neutrals, thus an open circuit. The fact that no current flows does not mean that the voltage is not induced in the concentric neutral wires. It is, and it should be limited to a maximum of 25 volts by limiting the circuit length.

INFORMATION SHEET 1.3.8.1I (continued)

QUESTIONS

1. Because aluminum is not as conductive as copper, what must be done when choosing cable size?

ANS: ____

2. What three (3) characteristics must be considered when working with aluminum conductors?

ANS: ____

3. What type of insulation shielding is provided over the insulation on UD cables?

ANS: ____

4. To eliminate circulating currents that create (I^2R) loss in and/or between concentric-neutrals of a three-phase circuit; what method is used?

ANS: ____

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.8.1J

(TITLE) Straight Splice, 15 kv, XLP, URD, Aluminum Splicing Instructions

INTRODUCTION

The instructions outlined in this job sheet are recommended by Kaiser Aluminum and are based on experience and tests believed to be reliable. Industry experience has shown that the splicer must use the proper materials and procedures in order to insure a completely satisfactory joint.

Read the entire job sheet before starting work, then turn to the first page of splicing instructions and begin splicing. Follow the sequence of steps and observe all safety precautions which apply.

REFERENCES

1. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 4-39 thru 4-46.
2. Terminations and Splices - Theory - Practice, PLM Products, 4799 W. 150th Street, Cleveland, Ohio 44135
3. UD Technical Manual, Cyprus Wire and Cable Company

EQUIPMENT AND MATERIALS

1. Tools
   a. Cable Splicers Tool Box
   b. Compression tool, Burndy Y34 A
   c. Hacksaw
   d. Sharpening stone
   e. Cable stripper
2. Expendable materials
   a. Cable, 15 kv, XLP (URD), AWG #1/0, 1/C, 5' per student
   b. Connectors, Mfg. Burndy

JOB SHEET 1.3.8.1J (continued)

(1) Ys25A, 1/0 (conductor)

(2) Ys25L, 1/0 (neutral)

c. Tape

(1) Vinyl, 3/4", 5970 00816 6056 (Scotch 88)

(2) Semi-conducting, Scotch 13, Bishop 17

(3) High voltage 3/4" X 30', 5970 00931 4491 (Scotch 23)

d. Abrasive cloth, Grit 320, 5350 00229 3086

e. Cleaning solvent, trichlorethylene

JOB STEPS

1. Train cables into position and overlap them about 6".

2. Bind down concentric-neutral strands - using several turns of PVC tape - at a point from end of cable that is a distance equal to 6" plus C plus D plus A plus half the length of connector to be used.

3. Without cutting away any concentric-neutral strands, unwrap them back to the binding of PVC tape. Using large pliers or other suitable tool, twist strands to form concentric-neutral. Combined with the taped binding, this will keep concentric strands in place when the cable is in operation. Bend twisted concentric strands out of the way temporarily.

4. Cut overlapped cables at center of lap, removing about 3" from each cable. Cut carefully so ends butt squarely.

5. Remove semi-conducting jacket from each cable for a distance equal to C plus D plus A plus half the connector length. Be careful not to cut insulation.

6. Taper jacket smoothly to approximately 5 times its thickness.

7. Remove insulation and semi-conducting strand shielding from end of conductor for distance A plus half the length of connector. Be careful not to nick conductor.

8. Taper insulation for distance D, using a penciling tool or sharp knife. If a knife is used, the taper must be buffed to even smoothness with non-conductive abrasive cloth. DO NOT use emery paper or cloth as they contain metallic particles. (Before tapering with a knife, exposed conductor should be protected with a few wraps of PVC tape. When taper is completed, remove protective tape and thoroughly clean exposed conductor.)

JOB SHEET 1.3.8.1J (continued)

9. Join aluminum conductors with suitable compression connector filled with contact aid. If connector is not filled, contact aid must be applied to conductor before installing connector. (A tapered connector, as designed for high voltage splices should be used.) If circumferential compressions are made, be sure to follow manufacturer's directions. File smooth any sharp edges or flash remaining after compressions are made. Clean off excess contact aid with alcohol or other solvent. Allow to dry thoroughly.

10. Clean exposed cable insulation with clean, lint-free cloth and suitable solvent - such as alcohol, perchlorethylene or trichlorethylene - to remove all traces of cable semi-conducting material. Avoid excessive use of solvent. Allow to dry thoroughly before next step.

11. (First, see Caution A.) Fill indents in connector with small pieces of semi-conducting tape, such as "Bishop No. 17". Apply a wrap or two of semi-con tape to conductor at both ends of connector to eliminate sharp edges and fill in shoulders between connector and conductor. Help form the semi-con tape so cross-sections at all points are as nearly circular as possible.

    Wrap half-lapped layer of semi-con tape smoothly over conductor and connector from bottom of one insulation taper to bottom of the other. Cover any semi-conducting strand shielding that extends beyond insulation tapers; overlap tapered cable insulation with semi-conducting tape no more than 1/16".

12. Starting at center of the connector, wrap high-voltage insulating tape, such as "Bishop No. W962" or equal, in half-lapped layers evenly back and forth over connector and onto insulation of joined cables. Tape should be stretched to manufacturer's recommendations. Continue wrapping evenly back and forth until thickness over connector equals T. Finish each layer slightly short of preceding one so wrapping will taper evenly at both ends. Tapers should cover all of distance C less 1/8".

    BE SURE THE HIGH-VOLTAGE INSULATING TAPE DOES NOT OVERLAP CABLE SEMI-CONDUCTING JACKET.

13. Wrap one half-lapped layer of semi-conducting tape over the insulating tape, extending it onto cable semi-conducting jacket for 1".

14. Clean exposed semi-conducting jacket between semi-conducting tape layer and concentric-neutrals. Use clean, lint-free cloth.

15. Cover all of the exposed factory and hand-applied semi-con with one half-lapped layer of Bishop W 962 insulating tape.

JOB SHEET 1.3.8.1J (continued)

16. Wrap two half-lapped layers of a high grade PVC tape such as "Bishop No. 85," over all of the insulating tape. Extend it to the concentric-neutral at each end of the splice. Wrap tightly, stretching tape so it conforms well. Apply last several wraps with no tension.

17. Bring concentric-neutrals together 2" to 4" from cable, about as shown. Overlap as necessary, then cut carefully so ends butt squarely. Join the two with suitable copper connector, following manufacturer's directions. For guide to suitable connector size, see table on page opposite.

INSTRUCTOR'S INITIALS ________

JOB SHEET 1.3.8.1J (CONTINUED)

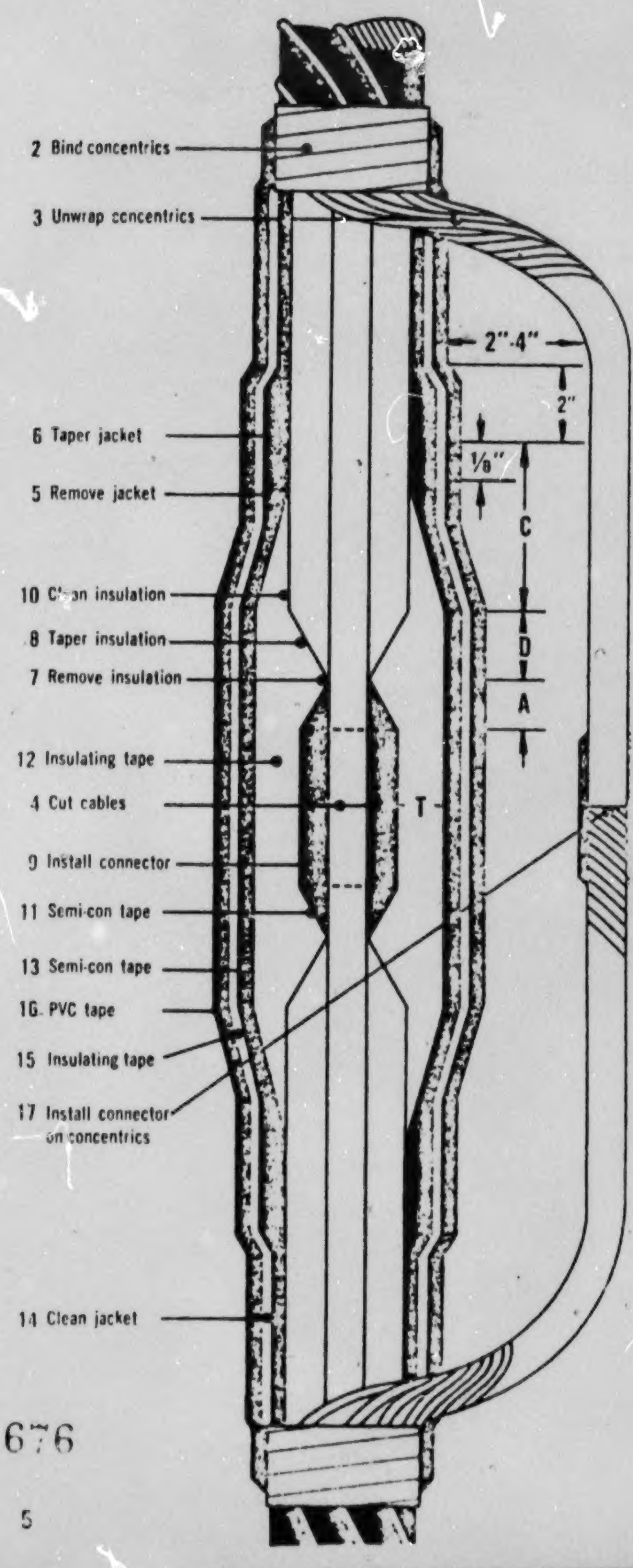
UD SPLICING DIMENSIONS

UD CABLE TYPE AND SIZE	A	C	D	T
15-KV Grounded		4 1/2"	1 1/2"	3/8"
25-KV Grounded		5 3/4"	2 3/8"	9/16"
35-KV Grounded		6 5/8"	2 7/8"	11/16"
4/0 and Smaller (all voltages)	1/2"			
Larger than 4/0 (all voltages)	1"			

COPPER CONNECTOR OR SLEEVE SIZES FOR CONCENTRIC NEUTRALS

Strand Size	#14	#12	#10
Number of Strands	CONNECTOR OR SLEEVE SIZE (AWG or MCM)		
7	#4	#2	#1/0
10	#2	#1/0	#3/0
13	#1	#2/0	#4/0
16	#1/0	#3/0	250
20	#2/0	#4/0	300
25	#3/0	250	350
32	#4/0	300	500

CAUTION A:
Once you start step 10, continue work on splice until you complete step 12 to avoid contaminating insulating tape with solvents, etc.



2 Bind concentrics
3 Unwrap concentrics
2"-4"
2"
1/8"
C
D
A
T
6 Taper jacket
5 Remove jacket
10 Clean insulation
8 Taper insulation
7 Remove insulation
12 Insulating tape
4 Cut cables
9 Install connector
11 Semi-con tape
13 Semi-con tape
16 PVC tape
15 Insulating tape
17 Install connector on concentrics
14 Clean jacket

676

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.9.10

(TITLE) 15 kv TERMINATION (ALL-TAPE), OUTDOOR WITH RAINSHIELD

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete this assigned splice. Before you proceed READ THE ENTIRE JOB SHEET, and if a kit is used be sure you read the instructions that come with it.

Once the splice has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of the insulation to the atmosphere.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable splicing practices and proficiency in the use of tools and materials.

REFERENCES

1. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, page 9-34, figure 9-56.

EQUIPMENT AND MATERIALS

1. Cable splicers tool box
2. Hacksaw
3. Sharpening stone
4. Compression tool, Burndy Indent
5. Cable, XLP, 15 kv, 3/C, AWG #2/0 (4' per student)
6. Terminal, Hydent YA26 (Burndy), (3 ea per student)
7. Tape
   a. High voltage ozone resistant tape "Scotch" 23
   b. Copper mesh "Scotch" 24
   c. Vinyl tape "Scotch" 33, GE #8380

532

JOB SHEET 1.3.9.1J (continued)

d. Rubber "putty" - "Scotchfil", NSN 9G 5970 00 045 3699

e. Track resistant tape (special applications)

f. Cotton tape

8. Copper wire, AWG #20

9. Rubber cement "Scotchkote"

10. Wire solder

11. Rainshield, PLM Cat. No. RHS, f/3/4" insulation diameter

12. Trichlorethylene

13. Wiping rags

JOB STEPS

Perform Job Steps as outlined in TR-5, Collyer, Mine Power Cable 5-15 KV Splicing Instructions, Collyer Insulated Wire Company, Lincoln, R. I.

INSTRUCTOR'S INITIALS __________

678

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.10.1J

(TITLE) ONE WAY-THREE WAY JOINT, THREE CONDUCTOR PILC TO THREE SINGLE CONDUCTOR XLP POWER CABLE

INTRODUCTION

This job sheet is designed for your use and it provides the necessary information that is needed to complete the assigned splice. Before you proceed read the entire job sheet, and any instructions that may be included with the splice.

Once the splice has begun it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of the insulation to the atmosphere.

Satisfactory cable joints are largely dependent upon the quality of workmanship; therefore, the splicer must have a knowledge of acceptable practices and proficiency in the use of tools and materials

REFERENCES

1. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 9-13 thr[illegible]-22.

JOB STEPS

1. Cable preparation

   a. Train cables to their final position and cut to proper length. Be sure cable ends butt squarely.

   b. Throughly clean cable ends. Ring and tin (PILC) ends at dimensions "A".

   c. Split the sheath of the PILC cable with the chipping knife up to the circumferential cut. Take care not to cut cable insulation.

   d. Tear split sections of sheath loose by pulling on one end directly away from the cable. Then remove the copper binder tape except for 3/4" from the end of the lead sheath. Be careful not to cut into the cable shielding.

   e. Remove cable metallic shields as per print dimension and solder them together with binder tape.

JOB SHEET 1.3.10.1J (continued)

f. Remove the cable insulation for 1/2 the length of the connector, plus 1/2". If a solder type connector is used, clean the conductor strands and apply stearine flux.

g. Remove the jacket and separator tape from the XLP cables. Do Not cut through the shielding tape or wires. Remove it up to dimension "A" plus 1/2".

h. Remove the metallic shielding tape or wires from this area for all but 1" and remove semi-conducting insulation shielding to 1/4" from the end of the shielding tape or wires.

i. Remove the cable insulation from the three XLP conductors for 1/2 the connector length plus 1/2". This should be done with a "FLM" stripper.

2. Preparation for connectors.

a. Install the split-tinned connectors, tighten with eagle-beak pliers and solder sweat. Polish connector thoroughly removing all projections.

b. Pencil the insulations of both cables 3/4". Use sharp knife and abrasive cloth to insure a smooth taper.

NOTE: Remember to wrap the end of the paper insulation with dry V.C. tape to prevent the insulation from unwrapping.

3. Preparation for lead sleeves.

a. Insulating the splice (joint).

(1) Build an oil stop on the three XLP conductors by putting eight (8) one-half lapped layers of varnished silk tape with a coating of lacquer, enamel, or oil stop compound between each layer. The oil stop is to go from the auxiliary sleeve to the middle of the connector.

(2) Fill the space between the connector and the lead covered cable insulation with 1/4" wide varnished cambric tape or fibermat III.

(3) Tape over the connector and pencil with 1/2" V.C. tape up to the level of the factory applied insulation.

(4) Build up splice with 3/4" V.C. tape.

(5) Apply one-half lapped layer of copper mesh tape over the 3/4" V.C. tape.

b. Boil out the paper side of the joint up to the connector only, do not go beyond. Thoroughly clean the XLP side. Keep each leg as straight as possible prior to and during the application of the tape.

c. Attach the banding wires.

4. Make a "Scotchfil" seal 3 inches from the end of the cable jacket.

5. Clean the lead sheath again and apply two half lapped layers of rubber tape for 3 inches along the sheath, starting 1 inch from the end.

6. Apply resin overcast sheath. Note: Refer to 3M Print 3M 2047-P-5.

7. Mix and inject resin through the P-1 injection fitting.

8. After the splice has cooled and set, prepare the cable for testing.

INSTRUCTOR INITIALS __________

536

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.11.10

(TITLE) PULLING-EYE ATTACHMENT

INTRODUCTION

This job sheet is designed to be used by you for actual step-by-step splicing procedures. A cable grip cannot always be used for pulling cable into a duct, either because of insufficient clearance or because of probable damage to the sheath in heavy pulls.

In such cases, when a factory-attached pulling eye is not available, the following steps of procedure are recommended for attaching a pulling eye in the field.

REFERENCE

Underground System Reference Book, 1957 Edition, Edison Electric Institute, pages 8-4 and 5, and 8-15, and 16.

EQUIPMENT AND MATERIALS

1. Tools
   a. Screwdriver
   b. Shoemaker's knife
   c. Chipping knives
   d. Six (6) foot wooden folding rule
   e. Safety goggles
   f. Splicer's cotton gloves
   g. Compound thermometer
   h. Wiping cloths
   i. Catch cloths
   j. Rasp and handle
   k. File and handle
   l. File cleaning brush
   m. Cableman's saw
   n. Pliers
      (1) Lineman's
      (2) Diagonal cutting
      (3) Cable claw
   o. Cable splicer's mirror
   p. Cable dresser
   q. Tinner's hammer
   r. Shave hook
   s. Tool box

2. Materials
   a. Abrasive cloth
   b. Paper pasters
   c. Solder 40/60 (wiping)
   d. Stearine candles
   e. Pulling bolt (size required)
   f. Tinned-copper wire #14

682

JOB SHEET 1.3.11.1J (CONTINUED)

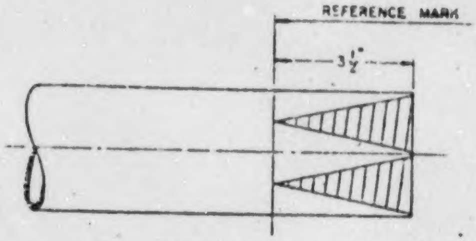
3. Equipment.
   a. Electric melting solder pot
   b. Tool pan
   c. Solder catch pan
   d. Solder ladles (2)

JOB STEPS

1. Cut end of cable square.

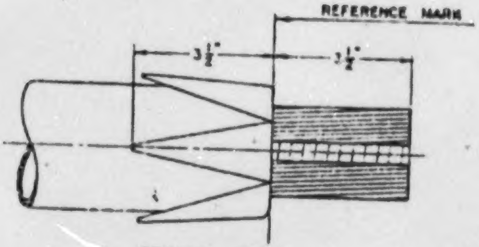
2. Mark lead sheath at 3-1/2 inches from cable end (reference mark).

3. First Step - Cut back to the mark with four "V" shaped cuts or more on large cables.



FIRST STEP

4. Second Step - Bend lead sheath back over cable and remove all insulation and metal tape.



SECOND STEP

5. Third Step - According to type of cable:
   a. Three conductor cable - Separate strands of all three conductors and bend back over sheath.

   Note: Cut inner jute 1-1/8 inches from reference mark (center filler).

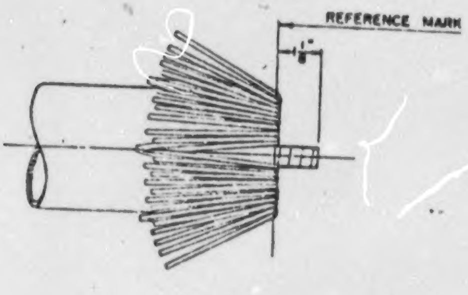
b. Single conductor cable - Bend the two outer layers of strands back over sheath, and cutt the remaining inner strands 1-1/8 inches from reference mark. For 250 MCM cable bend the three outer layers of strands back over sheath.

c. Concentric Cable - Bend the strands of the outer conductor back over sheath, and remove the insulation about the inner conductor. Cut the inner conductor 1-1/8 inches from reference mark.

Note: If pressure wires are used, remove insulation.

Caution: Do not use any bolt on which threads are in an unsatisfactory condition.

Note: Tine head and unthreaded portion of bolt thoroughly before installing in end of cable.

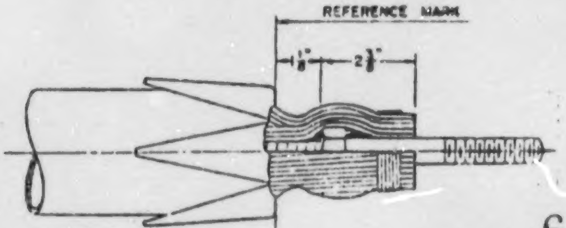


THIRD STEP

6. Fourth Step - Place head of bolt as shown in drawing. Then bend the outer strands over head of bolt to fit evenly on shank of bolt. Bind strands with six turns of #14 B. & S. copper wire and sweat thoroughly.

Note: If strands of outside layer do not fit evenly around shank of bolt, remove from outer layer three strands equally spaced from each other before making solder "sweat".

Note: To protect threads of bolt from getting solder in the threads apply a paper paster around the bolt. Also apply paper paster 1/2 inch beyond reference point after beat in of sheath.



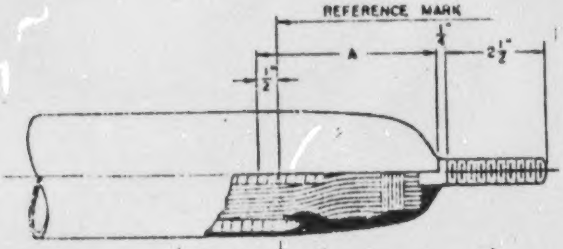
FOURTH STEP

7. Fifth Step - Beat ends of sheath forward over solder "sweat". From a point 1/2 inch beyond reference mark make a waterproof wipe over "sweat".

   Caution: Outside diameter of wipe must not exceed outside diameter of cable. Exercise care in making the wipe waterproof to insure against the entrance of moisture into the cable when pulling through the ducts.

   Note: Threads of bolt to be clean of any solder and well greased to insure easy running of nut.

   Note: Eye bolt and clevis type pulling eyes can also be used. Refer to reference for installation instructions.



A = 4 1/2" FOR 5" BOLT
A = 5" FOR 5 1/2" BOLT

FIFTH STEP

INSTRUCTOR'S INITIALS ____________

540

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

JOB SHEET 1.3.12.1J

(TITLE) LIVE END CAP ON A 15 KV RUBBER-LEAD, 1/C POWER CABLE

INTRODUCTION

This Job Sheet is designed to give you the actual step-by-step splicing procedures for live end caps in high voltage cables. Correct application of these procedures are essential to good trouble-free power service.

Before starting work be sure that the correct drawing, tools, materials and equipment are at the work site or on the truck. When you start splicing, it should be continuous and as rapid as good workmanship will allow in order to minimize the exposure of insulation to the atmosphere.

To obtain satisfactory high voltage cable splicing the splicer must use extreme care when working on the cable, because one wrong step or slip of the knife will cause the splice to fail. It may not fail today, but will often take several months or longer.

Therefore, the splicer must have a knowledge of acceptable splicing practices and be proficient in the use of tools, materials, and equipment.

Read the entire Job Sheet first; then, turn to the correct drawing and begin splicing, following proper steps of procedures for that drawing and observing all safety precautions.

REFERENCE

1. Underground Systems Reference Book, 1957 Edition, Edison Electric Institute, pages 9-24, 25 and 9-47

EQUIPMENT AND MATERIALS

1. Cable splicer's tool box
2. Cableman's saw
3. Eagle claw
4. Soldering iron and handle
5. Connectors, solder, sweated, split type tinned

JOB SHEET 1.3.12.1J (continued)

6. Tapes
    a. Rubber
    b. Plastic
    c. Varnished-cambric-oil
    d. Friction and anhydrous
    e. Cotton

7. Filling materials
    a. Fluid
    b. Semi-fluid
    c. Plastic, oil-soluble
    d. Plastic, oil-insoluble
    e. Plastic, resin

8. Lead sleeves

9. Abrasive cloth

10. Live end caps
    a. Size 1
    b. Size 2

11. Paper pasters

12. Solder, 40/60 wiping

13. Solder SN 50 wire

14. Stearine candles

15. Copper braid tape tinned or untinned

16. Electric melting pot

17. Tool pan

18. Solder catch pan

19. Compound kettles

20. Solder ladles

21. Paraffin ladles

22. Paraffin pan

23. Paraffin

JOB SHEET 1.3.12.1J (continued)

JOB STEPS

1. Cable preparation.

   a. Cut the cable end square using one of the following:

      (1) Cableman's saw

      (2) Hacksaw

   b. Measure and mark the sheath at 6 1/2" for a 15 kv, VCL cable.

   c. Ring the cable sheath with a chipping knife and tinner's hammer. CAUTION: Only ring cable sheath half-way through.

   d. Clean the lead sheath 3 to 4 inches back from the cable ring using a shave hook.

   e. Apply stearine to the cleaned portion of the cable.

   f. Apply pasters

      (1) One paster to cover ring and 1/2 inch of the cleaned portion of the sheath.

      (2) One paster at the other end of the cleaned area.

   g. Tin the cleaned portion of the sheath

   h. After tinning remove paper pasters

   i. Remove the lead sheath using the chipping knife and tinner's hammer. CAUTION: Do not nick or damage belting, shielding or insulation. When slitting and removing the sheath use a twisting motion so as to leave a natural bell.

   j. Remove the shielding or semi-conducting tapes back 1/4" from the sheath.

   k. Remove one layer of varnished-cambric insulation after the semi-conducting tape is removed.

2. Cap preparation

   a. Check the drawing for the correct size of end cap to be used for this cable.

b. Remove or build up conductor insulation with 3/4 inch dry or oil varnished-cambric tape where required to snugly fit the molded test cap.

c. Apply taping compound on the end of the conductor and between the layers.

d. Coat the inside of the test cap with taping compound and slide over the conductor. Slightly turn the cap in the direction of tape lay to keep the tape from unraveling.

e. Start taping the live end cap with oil immersed V.C. tape 1/4" from the end of the sheath or tape shielding. Taper this up over the test cap. For 15 kv cover the mold to a dimension of 3/16".

f. Apply the shielding stress cone.

(1) Start from 1/2" on the cleaned portion of the lead sheath.

(2) Build up the shielding at the natural bell of the sheath to form a smooth taper.

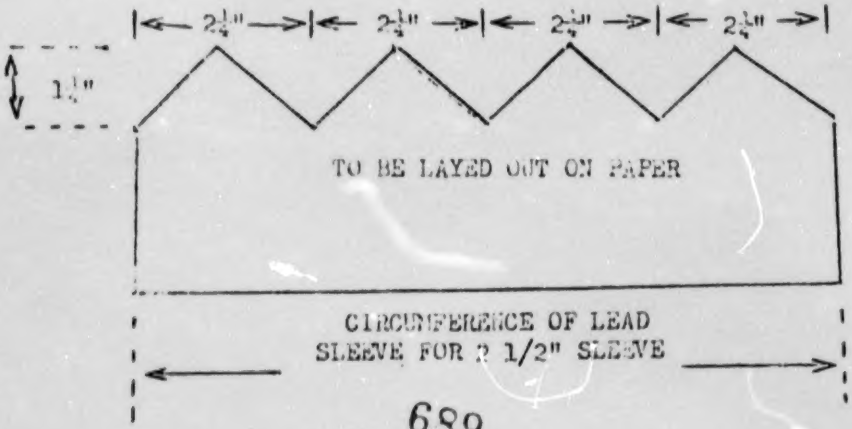
(3) One layer should be half-lapped to the distance required on the drawing or high point of the insulation taper.

(4) Solder the stress cone shielding on two (2) sides of the cable sheath.

(5) Spot solder the shielding around the stress cone. Do not use excess solder when spot soldering the stress cone.

g. Prepare and apply lead end sleeve.

(1) Seal one end of the lead sleeve by cutting four tabs as shown below and beat in the tabs evenly and apply paster (1/2") one-half inch from beat in and solder the wipe end.



JOB SHEET 1.3.12.1J (continued)

(2) Clean the sleeve 3 to 4 inches and apply stearine to the cleaned area.

(3) Slide the sleeve over the end cap and cable. Caution: DO NOT DAMAGE INSULATION.

(4) Beat down the end of the sleeve evenly to fit snug to the cable sheath.

(5) Apply paper pasters at the ridge of the sleeve where the beat down begins and for the correct distance away from the sleeve on to the cable sheath. NOTE: The correct distance as previously taught in reference to cable diameter.

(6) Wipe the lead sleeve with wiping solder. CAUTION: Observe applicable safety precautions when handling molten solder.

(7) Remove pasters.

h. Fill the sleeve with taping compound and let it cool. Then check and refill with compound if necessary.

i. Seal or plug filling assembly or holes.

j. Apply arc and fire proofing tape as required.

k. Tape the ends of the arc and fire proofing tape with glass tape to keep the ends from unraveling.

l. Support the end of the cable according to the installation being used.

m. Tag the cable with the following information:

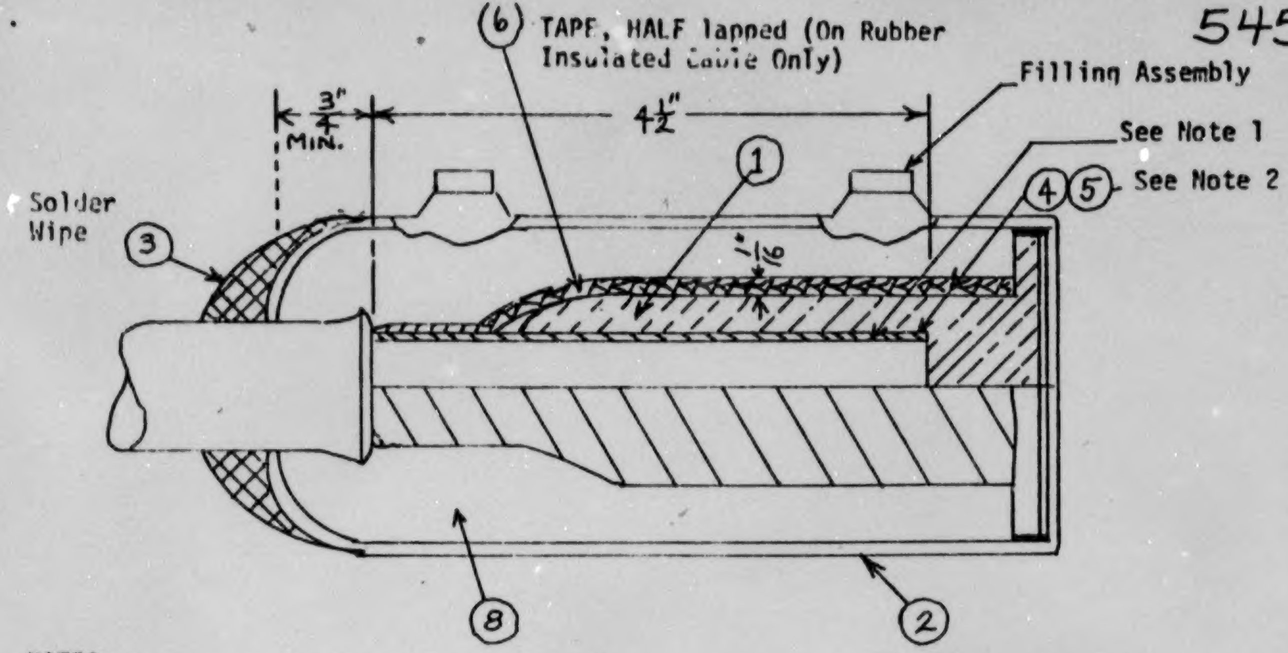
(1) Cable number (Feeder #).

(2) Phase (if single conductor).

(3) Voltage rating.

(4) "LIVE END CAP" DANGER HIGH VOLTAGE

INSTRUCTOR'S INITIALS ________



NOTES:

1. Remove rubber-filled tape on rubber-insulated cable.
2. Conductor insulation to be built up with rubber tape on rubber-insulated cables and with varnished cambric tape on other insulated cables.
3. On rubber insulated cables, use test cap Type No. 1 for conductors up to and including 4/0 AWG, and Type No. 2 for 350 MCM and 500 MCM conductors. On paper-insulated cables, Use Test Cap No. 1 for conductors up to and including 500 MCM

ITEM NO.	DESCRIPTION	DWG. OR SPEC. NO.	UNIT	QUANTITY	
				RUBBER INSULATED	PAPER INSULATED
1	MOLDED TEST CAP - SEE NOTE NO. 3	E 64 31	each	3	3
2	Lead End Sleeve 2 1/2 x 9"	EO 1590 C	each	3	3
3	Pig Solder 40-60 Tin Lead, Grade 40A	EO 100,052	pound	3	3
4	Ozone Resistant Rubber Tape, 3/4 Wide	EO 100,001	roll	3	-
5	Varnished Cloth Tape Dry - 12 Mil. 3/4 Wide	EO 100,068	18 yd roll	-	3
6	Friction Tape 3/4" Wide	EO 6012	roll	1	-
7	Paper pasters - 2 1/2" x 12" strip	E-54-30	each	6	6
8	Plastic Filling Compound	E-57-30	pint	6	6
9	Stearine Flux	---	2 oz stick	1	1
10	Wiping rags	G 2-39	ounce	6	6

Supersedes Dwg. No. 8850, Fill No. 1840-B

LIVE END CAP
SINGLE CONDUCTOR CABLE
5000 VOLTS

CONSOLIDATED EDISON COMPANY OF N.Y., INC.

DATE 12-5-59
LAST REV. 9-17-61

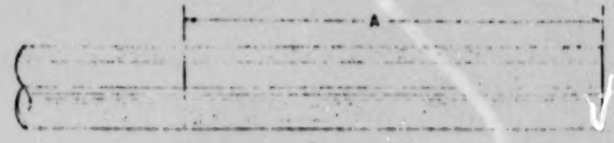
DWG. no. EO-~~8399~~ 691-C

REV. 1

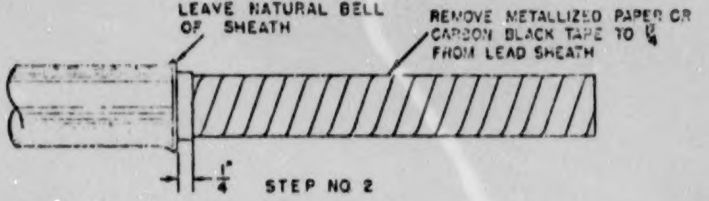
546

CODE NO	RATED VOLTAGE (KV)	SIZE OF CONDUCTOR (B&S OR MCM)	LEAD SLEEVE		A	MOULDED TEST CAP TYPE NO.
			I.D	LENGTH		
L-1	15	60	2 1/2	9	6 1/2	1
L-2	15	2/0 *	2 1/2	9	6 1/2	1
L-3	15	250	2 1/2	9	6 1/2	1
L-4	15	300	2 1/2	9	6 1/2	1
L-5	15	750 *	3	9	6 1/2	2
L-6	15	1000	3	9	6 1/2	2
L-7	27	2/0	2 1/2	11	8 1/2	1
L-8	27	500	3	11	8 1/2	2

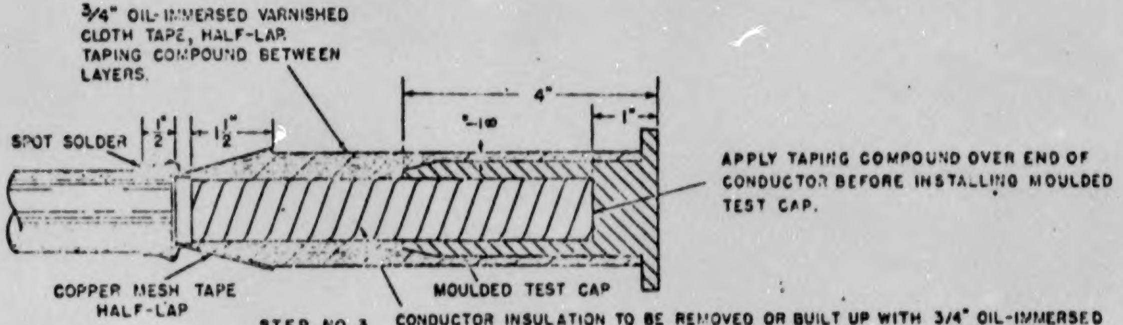
* 2/0 B&S AND 150 MCM SIZES AS WELL AS 750 MCM AND 600 MCM SIZES ARE INTERCHANGEABLE.



STEP NO. 1

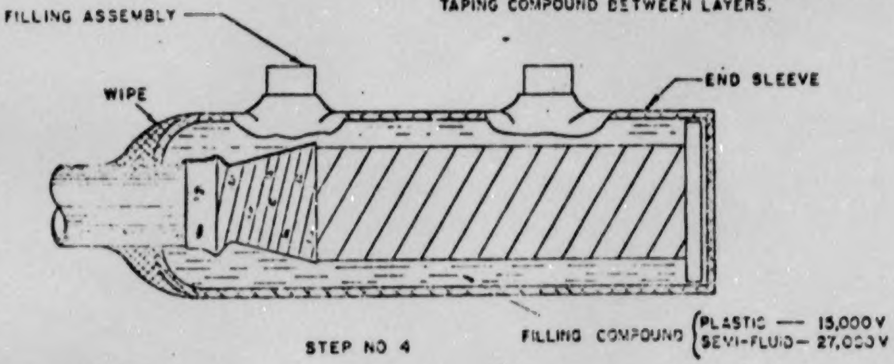

LEAVE NATURAL BELL OF SHEATH
REMOVE METALLIZED PAPER OR CARBON BLACK TAPE TO 1/4" FROM LEAD SHEATH
1/4"

STEP NO 2


3/4" OIL-IMMERSED VARNISHED CLOTH TAPE, HALF-LAP. TAPING COMPOUND BETWEEN LAYERS.
SPOT SOLDER
1/2"
1 1/2"
4"
1"
APPLY TAPING COMPOUND OVER END OF CONDUCTOR BEFORE INSTALLING MOULDED TEST CAP.
COPPER MESH TAPE HALF-LAP
MOULDED TEST CAP

STEP NO 3

CONDUCTOR INSULATION TO BE REMOVED OR BUILT UP WITH 3/4" OIL-IMMERSED VARNISHED CLOTH TAPE WHERE REQUIRED TO SNUGLY FIT MOULDED TEST CAP. TAPING COMPOUND BETWEEN LAYERS.


FILLING ASSEMBLY
WIPE
END SLEEVE
FILLING COMPOUND
PLASTIC — 15,000 V
SEMI-FLUID — 27,000 V

STEP NO 4

622

NOTE-
SEE REVERSE SIDE FOR BILL OF MATERIAL.

LIVE END CAP
SINGLE CONDUCTOR CABLE
15,000 AND 27,000 VOLTS
CONSOLIDATED EDISON COMPANY OF N.Y. INC.

CONSTRUCTION ELECTRICIAN SCHOOL

CE "C" CABLE SPLICING

INFORMATION SHEET 1.4.1.1I

(TITLE) TOOLS, MATERIALS, AND EQUIPMENT

INTRODUCTION

This information sheet has been designed to provide you with the source and price of the various tools, materials and equipm[illegible] required for telephone and power cable splicing, testing and loca[illegible] faults.

The quantity and cost will vary due to your requirements, local prices, and manufacturer.

Also included is a list of manufacturers and main office addresses. Normally these companies have a branch or agency in most of the principal cities.

REFERENCES

Defense Supply Agency Catalogues

Manufacturers Catalogues

Associated Research, Inc., 6125 Howard Street, Chicago, IL 60648
Phone: (312) 647-7850

Automatic Electric Company, Northlake, IL 60164
Phone: (312) 562-7100

Burndy, Norwalk, Connecticut 06856

Manhattan Electric Cable Corporation, Executive Offices
Station Plaza, Rye, N.Y. 10538
Phone: (914) 967-4080

David Glove Company, Houston, Texas 77113

G & W Electric Specialties Company, 3500 West 127th Street,
Blue Island, IL 60406

General Machine Products Company, Old Lincoln HyWy at
Pennsylvania Turnpike, Trevose, PA 19047
Phone: (215) 357-5500

Insulation Manufacturing Company, 301 Locust Ave.,
Oakdale, N.Y. 11769
Phone: (516) 589-7300

INFORMATION SHEET 1.4.1.1I (CONTINUED)

3 M Company, Minnesota Mining and Manufacturing Company
Electro Products Division, 3M Center, Saint Paul, Minnesota 55101

3M TelComm Products Department, Building 220-3E, St. Paul, MN 55101

H. K. Porter, Inc., Somerville, Massachusetts 02143
Phone: (617) 776-8200

PLM Products, Division of Scott & Fetzer Company,
4799 West 150th Street, Cleveland, Ohio 44135
Phone: (216) 267-7080

Richard Mfg. Co., 152 Coit St., Irvington, NJ 07111
Phone: (210) 371-1771

Thomas and Betts Inc., Elizabeth, NJ

Somerset, Division of T & B, Circle Drive North, Piscataway, NJ 08854

Western Electric Company, Inc., Defense Activities Division,
83 Maiden Lane, New York, N. Y. 10038
Phone: (212) 571-5718

INFORMATION

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Portable DC Hypot HV Tester	6625-00-298-9638	$3,115.00
Telephone Test Set TS 420/U 760	Western Elect.	300.00
Volt-Ohmeter, Mod. 240	Simpson	75.00
Exploring Coil, 101B	Western Elect.	25.00
Exploring Coil, 75A	Western Elect.	25.00
Head Set, Tele/Test	Western Elect.	40.00
Compression Tool, Y-34-A, Hyd 9 Ton	9Q5120-00-293-2316 Burndy Mfg. Co.	192.59
Compression Tool, MY 29-3	Burndy Mfg. Co.	55.00

INFORMATION SHEET 1.4.1.1I (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Compression Tool, T&B # TBM-8	Thomas and Betts	150.00
Compression Tool, T&B # TBM-Kit	Thomas and Betts	165.00
Pliers, Eagle Beak	B. S. Barnard Co.	20.00
Chain Hoist	A. B. Chance Co.	150.00
Dynamometer	A. B. Chance Co.	75.00
Saw, Cableman's	5110-00-273-0101	4.74
Saw, Hacksaw	5110-00-289-9657	1.97
Bond Drift Plugs, 1"	General Machine Products GMP 6636-2	6.00
Bond Drift Plugs, 1¼"	GMP 6636-3	6.50
Bond Drift Plugs, 1½"	GMP 6636-4	7.00
Bond Drift Plugs, 1 3/4"	GMP 6636-5	7.50
Bond Drift Plugs, 2"	GMP 6636-6	8.50
Bond Drift Plugs, 2½"	GMP 6636-8	9.50
Bond Drift Plugs, 2 3/4"	GMP 6636-9	11.50
Bond Drift Plugs, 3"	GMP 6636-10	13.00
Bond Drift Plugs, 3½"	GMP 6636-11	18.50
Bond Drift Plugs, 4"	GMP 6636-12	20.00
Potheads, Capnut	Gulf & Western C&W 5 kv WS-31	49.00
Vice, Machinists	5120-00-293-1439	46.80
"B" End Platemold	GMP Cat. 7292	107.00
Soldering Copper, w/Handle	GMP Cat. 67223	9.00

INFORMATION SHEET 1.4.1.1I (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Cable Cutter	H. K. Porter Cat. No. 190 CS	56.00
Cable Cutter, 32"	Somerset Cat. No. UT 366 FR	90.88
Cable Cutter, 20½"	Somerset Cat. No. UT 366 FR	85.00
Cable Cutter, Hydraulic, 3"	H. K. Porter Cat. No. 179089	157.00
Hacksaw, Power	Mfg. Keller Mod. 3-B	380.00
Kettle, Compound, 3 gal.	5120-00-596-1074	21.80
Kettle, Compound, 5 qt.	General Machine Products GMP 6130	25.00
Furnace, Butane, w/tank	Goss Gas Inc.	86.46
Tank, Acetylene, "B" 20 cu. ft.	Goss Gas Inc.	50.00
Tank, Acetylene, "MC" 10 cu.ft.	Goss Gas Inc.	30.00
Furnace, Melting, Elect.	Gen. Elect. GE2881146	20.00 Est.
Windshield, used w/Furnace	Automatic Elect. AWS577876	36.52
Heating Unit, 1000W, F/Furnace 115V	Gen. Elect. GE3A228G3	20.00 Est.
Pot, Solder, Melting, 5"	5120-00-540-4134	2.11
Handle, Pot Hook	GMP 7170	4.00
Pan, Solder, Lg.	GMP 6874	6.00
Pan, Solder, Sm	GMP 6877	6.00
Dipper, Parafin	GMP 6679	3.50
Pot, Parafin, 12" X 9"	5120-00-293-3550	13.39
Test Pick	Western Elect. GMT-6491	3.00

INFORMATION SHEET 1.4.1.11 (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Die Set, Metal, ¼" Numbers	5110-00-289-0003	5.41
Die Set, Metal, ¼" Letters	5110-00-289-0007	25.06
Pencil Tool, PT10C	PLM	30.00
Pencil Tool, PT20C	PLM	30.00
Pencil Tool, PT 40C	PLM	35.00
Pencil Tool, PT250C	PLM	35.00
Insul. Stripper, 15Q	PLM	38.50
Resin Pressure Gun "E-4"	3M Company	46.73
Furnace, Gasoline	A.L. 5573986	27.00
Lead Sleeve Slitter "B"	GMP 7449	3.75
Wires, f/Slitter	GMP 7449-W	.40
Drill, Cable .280	GMP 6797	9.00
Drill, Cable .480	GMP 7533	17.50
Clamp, Pressure Test	GMP 6565	8.00
Pump, Pressure Test "B"	GMP 7072	22.50
Soap Bucket	GMP 7271	8.00
Solder Set	9Q3433-00-889-1796	27.66
Tape, Semi-Con # 13	5970-00-441-8629	1.80
Tape, Hi.Volt. Rub. 23	5970-00-931-4491	1.73
Tape, Shielding #24	3M, PLM	3.00
Tape, Glass ½" X 180', #27	5970-00-543-1154	1.37
Tape, Glass 1" X 180'	5970-00-686-9151	4.07
Tape, Plastic, 33+	5970-00-788-4901	1.14

INFORMATION SHEET 1.4.1.11 (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Tape, Silicone Rubber # 70	5970-00-840-8454	5.88
Tape, Plastic, 3/4" Ply	5970-00-419-4291	.94
Tape, Vinyl, 1" #88, 108'	5970-00-419-3164	1.07
Tape, Plastic 1½" X 108'	5970-00-150-2009	1.88
Tape, Vinyl, Mastic, Roll 4" X 10'	3M #2210	6.20
Tape, Varnished Cambric, 3/4"	3M #2510	1.95
Tape, Scotchfill	5970-00-045-3699	1.54
Tape, Fibermat, III, ¼"	3M #2551	1.40
Tape, Fibermat, III, ½" Oil Immersed	3M #2551	1.54
Tape, Fibermat, III,3/4"	3M #2551	1.55
Oil Stop	3M, Irvington 621	1.23
Resin, "Scotchcast" #4-B	5970-00-682-8999	3.24
Resin, "Scotchcast" #4/C	5970-00-814-1788	6.04
Elect. Abrasive Grit, 80	5350-00-187-6284	4.84
Elect. Abrasive Grit, 320	5350-00-187-6289	5.66
Injection Fitting, P-1	5175-00-992-3589	.36
Nozzle, P-5	5175-00-992-3590	.24
Tape, Spacer, P3	5975-00-909-2053	2.52
Tape, Restricting, P4	5975-00-574-8117	1.70
Glyptal, ½ Pint	5970-00-900-9372	.59
"Scotch Kote"	5970-00-962-3335	1.66
"K" Termination Kit	5940-00-578-0956	15.70

INFORMATION SHEET 1.4.1.11 (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Splice Kit, 82-A2	5970-00-810-1512	4.10
Comm. Cable Capping Kit	3M #3820	1.51
Splice Kit, 89D2	5975-00-657-1544	6.38
Tape Aluminum, 4" X 20', #49	7510-00-071-6854	4.80
Tape Aluminum, 2" X 20', #49	3M #	2.60
Splice KIT, Power	Tomic BW-301A	14.25
Term. Kit, Power	Tomic PSR-13	16.50
Tape, Friction, 3/4"	5970-00-644-3167	.56
Paste. "Pentrox"	5975-00-905-8075	2.20
Flux, Stick f/Copper	GE 1523 A10A3	.35
Stearine Candle	General Machine Products GMP-4320	.26
Solder 50/50	3439-00-163-4347	3.26
Solder 40/60	3439-00-247-6921	2.30
Solder, SN 50, Wire Roll	3439=00=273-1637	12.41
Rags, Wiping	7920-00-205-3590	43.00
Paraffin, lb.	GMP/A.E.	1.50
Flux, Soldering	3439-00-255-4571	.21
Tape, Textile ½"	GMP 6684-A	.90
Tape, Cotton	GMP-6684B	1.25
Tape, Pasters, Gummed, 2"x60'	8135-00-908-0547 GMP-6865	.60
Muslin, 4" X 10 yds	GMP-6727-4	.85
Sleeves, Cotten 1/8	5970-00-189-5911 GMP-6436-D	1.30

INFORMATION SHEET 1.4.1.1I (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Sleeves, Cotton 5/32	5970-00-189-5912 CMP-6436-C	1.37
Sleeves, Cotton 1/4"	5970-00-189-5913 GMP-6436-D	2.72
Sleeves, Cotton 1/4"	5970-00-189-5900	.65
Sleeves, Filled, Plastic, .085 Yellow	5970-00-821-6666	.03
Sleeves, Filled, Plastic, .05 Green	5970-00-344-3111	2.30
Sleeves, Filled, Plastic, .45 Red	5970-00-089-4493	.04
Sleeves, Filled, Plastic, .125 Clear	5970-00-089-4495	.03
Sleeves, Filled, Plastic, .165 Blue	5970-00-089-4494	.04
Connector, Tele "B", AT-7759 (WE CO. "B")	5940-00-949-4008	.05
Sleeve, Plastic, .106 Yellow	General Machine Products GMP 7574-Y	1.45
Sleeve, Plastic, .133 Red	GMP 7574-R	1.60
Sleeve, Plastic, .166 Blk	GMP 7574-BLK	1.75
Splice, "Pick-A-Bond, Red AWG 24-19	5940-00-177-2630	.06
Splice, "Pick-A-Bond, Grn AWG 26-22	5940-00-177-2628	.06
Cable, Telephone, 26 PR., PILC, 22 GA.	6145-00-223-4782	.56
Cable, Telephone, 51 PR., PILC, 22 GA.	6145-00-220-9925	.67

INFORMATION SHEET 1.4.1.11 (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Cable, Telephone, 101 PR., PILC, 22 GA.	6145-00-220-9926	1.25
Cable, Telephone, 25 PR., PIC, 22 GA.	6145-00-577-8064	.37
Cable, Telephone, 50 PR., PIC, 22 GA.	6145-00-577-8072	1.28
Cable, Telephone, 100 PR., PIC, 22 GA.	6145-00-577-8081	1.61
Cable, Telephone, 200 PR., PIC, 26 GA.	6145-00-683-0813	1.21
Cable, Telephone, 25 PR., Figure "8", 19 GA.	6145-00-781-6717	.51
Cable, Telephone, 50 PR., Figure "8", 22 GA.	6145-00-999-3431	.97
Cable, Power, #8 AWG, 1/C RR, 5 K.V.	PC 880	.31
Cable, Power, 4/0 AWG, 1/C, RL, 5 K.V.	MEC PC 713	2.16
Cable, Power, 4/0 AWG, 1/C, XLP, 5 K.V., S.	MEC PC 2317	2.50
Cable, Power, 4/0 AWG, 3/C, XLP, 5 K.V., Shielded	MEC PC 2417	8.40
Cable, Power, 4/0 AWG, 1/C, XLP, 15K.V., Shielded, Grnd.	MEC PC 2670	2.65
Cable, Power, 4/c AWG, 1/C, XLP, 15 K.V., shielded, UNGRND.	PC 2691	3.16
Cable, Power, 2/o AWG, 3/C, XLP, 15 K.V., Shielded, Grnd., w/Neutral	MEC PC 2455	5.50

INFORMATION SHEET 1.4.1.11 (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Cable, Power, 250 MCM, 3/C, XLP, 15 K.V., without Neutral Shielded Grnd.	MEC PC 2458	8.75
Cable, Power, 500 MCM, 1/C, EPR, 15 K.V., Compact, Unishield	PC 3481	No Cost Excess
Cable, Power, 500 MCM, 1/C, EPR, 15 K.V., Concentric Shielded	PC 1770	No Cost Excess
Cable, Power, #2 AWG, 1/C, EPR, 29 K.V., Shielded, Grnd.	MEC PC 1700	No Cost Excess
Cable, Power, #1/0 AWG, 1/C, XLP, URD, Aluminum, 15 K.V.	MEC PC 3622	.47
Cable, Power, #1 AWG, 1/C, XLP, URD, Aluminum, 25 K.V.	MEC P2 3640	No Cost Excess
Cable, Power, 4/0 AWG 1/C, VCL 5 K.V.	MEC PC 4046	3.00
Cable, Power, 4/0 AWG 3/C, VCL 5 K.V.	MEC PC-4231	7.80
Cable, Power, 4/0 AWG 1/C, VCL 15 K.V., UNGRD	MEC PC-4189	3.60
Cable, Power, 2/0 AWG 3/C, PILC 15 K.V.	MEC PC 4408	No Cost Excess
Cable, Power, 4/0 AWG 3/C PILC 15 K.V.	MEC PC 4410	No Cost Excess
Connectors, "Scotchlock" UR	5940-00-988-6311	5.63
Connectors, "Scotchlock" UG	5940-00-070-9621	5.00
Connectors, "Scotchlock" UY	8060-11-0900-4	5.50
Sleeving, Lead 1½" X 72"	5975-00-280-3384	8.77

INFORMATION SHEET 1.4.1.11 (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Sleeving, Lead 1 3/4" X 120"	5975-00-993-6089	23.50
Sleeving, Lead 2" X 72"	5975-00-509-2462	12.40
Sleeving, Lead 2½" X 72"	5975-00-509-2463	18.70
Sleeving, Lead 3" X 120"	5975-00-393-2095	59.00
Sleeving, Lead 3½" X 120"	5975-00-393-2096	32.00
Sleeving, Lead 4" X 120"	5975-00-393-2097	50.90
Connector, AWG 8, T&B 54504	5940-180-7953	.37
Connector, AWG 2, T&B 54507		1.00
Connector, AWG 2	Burndy YSIC	1.00
Connector, AWG 1/0, Aluminum	Burndy YS-25-A	1.16
Connector, AWG 2/0, Solder	Richards, Cat. #10	.84
Connector, AWG 4/0, Solder	Richards, Cat. #12	1.13
Connector, AWG 250, 4.0, Solder	Richards, Cat. R-13	3.89
Connector, AWG 4/0 - 2/0, Solder	Richards, Cat. R-12	3.20
Connector, AWG 4/0 - 4/0 - 4-0	Richards, Cat.	4.08
Connector, AWG "Tee" 4/0	Richards, Cat. T-12	5.15
Connector, AWG, 4/0 Crimp	5940-00-258-5899	1.6.
Terminal, Crimp, 4/0	5940-00-841-3783	1.66
Terminal, Crimp, 2/0	5940-00-087-0887	.68
Connector, AWG 500	ILSCO CTL-500	2.88
Terminal, Crimp 500	ILSCO CRA-500	2.88

INFORMATION SHEET 1.4.1.1I (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Live End Cap #1	Insulation Mfg. Co.	8.25
Live End Cap #2	Insulation Mfg. Co.	8.25
Steel Tool Box	A.E. # S571380	15.58
Fiber Test Board	A.E. # S571330	.72
Shave Hook	General Machine Products GMP-7151	3.96
Scratch Awl	5120-00221-1542	.80
Electricians Scissors	5110-00754-1499	2.21
Cleaner, File, Combination	7920-00224-7967	1.34
Folding Rule, 6'	5210-00293-3511	1.90
Cable Splicers Mirror	5120-00892-5709	.89
Screwdriver, 6" X 5/16"	5120-00764-8059	.84
Lineman's Pliers 8"	5120-00756-1156	2.58
Diagonal Pliers 6"	5110-00239-8253	2.68
Calipers, Outside General	5210-00229-3048	2.97
Knife, Taper	5110-00268-3882	.39
Knife, Straight, Shoe	5110-00595-8403	.38
Knife, Cable Sheath, (small)	5110-00596-1093	6.08
Knife, Cable Sheath, (large)	J. Stortz & Son	3.84
Wooden Cable Dresser	GMP 46-L-113	11.50
Pouring Ladles, 3/4 pint	GMP 6085	6.50
Wiping Cloth 2" X 2"	A.E. # S5720222	1.00
Wiping Cloth 3" X 3"	3439-00576-0897	1.38

INFORMATION SHEET 1.4.1.11 (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Wiping Cloth 4" X 4"	A. E. # S572026	1.02
Flat Catch Cloth, 6" X 6"	9G3439-00576-0896	1.85
Flat Catch Cloth, 8" X 8"	3439-00408-0337	1.19
Safety Goggles	4240-00052-3776	.71
Tinners Hammer	5120-00236-3722	3.37
Handle and Rasp, 12"	5110-00233-9712	2.91
File, Flat Bastard 12"	5110-00242-5386	1.76
Temperometer	A.E. # S578725	16.67
'B" Cable Sheath Opener	GMP - 7274	3.00
Long Wristlet Cotten Gloves	David Gloves	.57
Work Gloves, Cotten	8415-00268-8330	1.04
Wooden Separator		
Pliers, Combination, 8"	5120-00223-7397	1.29
Wrench, Adj., 8"	5120-00240-5328	1.92
"B" Connector Pressure Tool	5120-00939-6185	35.00
Scotchlok Cartridge Tool	E9C	40.00
Scotchlok Crimping Tool	3M Co. "E9" Tool	9.15
Wrench Telescoping	5120-00868-0831	2.18
Cable Stripper Jones 2 Way	905110-00-238-7696	38.48
Tabbing Shear	CMP No. 7669	12.00
Stripper 22 AWG, GA.	AE-S-578419	3.28
VS-3 Pick-A-Bond Tool Crimping Tool	5120-00-421-0435	2.30

560

INFORMATION SHEET 1.4.1.1I (CONTINUED)

Type Designator & Nomenclature	National Stock Number	Per Item Cost
Tool Holder Adapter	5120-00-421-0451	3.45
Leadwedges	5975-00-908-9472 GMP 6783-1	.38
Leadwedges	5975-00-534-8756 GMP 6783-2	.55
Leadwedges	5975-00-408-4460 GMP 6783-3	.58
Leadwedges	5975-00-356-4943 GMP 6783-4	.86
Splice Closure 1A1	5805-00-835-0134	25.29
Splice Closure 1B1	5805-00-835-0143	14.70
Splice Closure 49A2	5805-00-084-0202	8.28
Splice Closure 49B2	5805-00-084-0200	5.90
Buried Tele Closure	3M BD/25C 2"	9.71
Tele Shield Connector	3M 4461	.75
VS-3 Tool Holder	5120-00-350-3716	14.46

706

CHAPTER 12

TELEPHONE CABLE SPLICING

In this chapter we will discuss telephone cable splicing in such a way that you will recognize the importance of this vital procedure for keeping communication lines operating properly. Upon completion of this chapter, you should be able to perform telephone cable splicing safely, economically, and efficiently.

The knowledge you acquire in this chapter regarding cable terminology, types of cable and the procedures for splicing a variety of cables will enable you to render vital services in the communication link.

Most lines, whether for telephone or for power distribution, require some splicing. The length of cable on a reel seldom equals exactly the length to be installed. Even after a system has been installed, there will always be a certain amount of splicing necessary, to take care of repairs on defective cable sections, or to add extra sections to the main cable.

Most splicing on power lines is done underground, by the methods described in chapter 10. However, most telephone line consists of aerial cable. Let's begin this chapter with a discussion of telephone cable.

TELEPHONE CABLE TERMINOLOGY

Cable for telephone communications may be classified as aerial, buried, submarine, and underground. The greater amount will be aerial cable, but there is always some underground cable in a communications system, and there is likely to be some buried and some submarine cable.

Aerial cable is lead- or plastic-covered cable suspended on poles. Buried cable is underground cable placed without conduit—that is, buried "directly." Tape-armored (or jute-protected) cable is the type most frequently used for direct burial. Regular underground cable is placed in conduits. Submarine cable is a metal tape armored type suitable for operation in swampy land or water.

CLASSIFICATION OF CABLES

The size designation of a power cable indicates its power-carrying capacity. With telephone cable, the size designation indicates the number of pairs of conductors in the cable.

Outside cables for telephones are, like power cable, usually lead-sheathed. However, the wires inside a lead-covered telephone cable are insulated with paper. The insulation may be sprayed on as pulp, or the paper may be wrapped spirally around the conductors. Double-wrapping of wires provides a highly dielectric (nonconducting) insulation, both because of the additional thickness of the paper and because of additional air space. This higher insulation protects against insulation breakdown which might occur if a telephone line came into contact with a power line.

Broadly speaking, telephone cable may be classified as tape-armored cable, building and switchboard cable, and plastic-covered cable.

Tape-Armored Cable

Tape-armored cable is a lead-covered cable fitted with a protective covering of paper, jute, and steel tape. This tape is available to match standard lead-covered cables. It protects the cable against damage by rodents and against mechanical damage when the cable must be buried directly (without conduit).

Tape-armored cable is quadded, color coded, and composite. In quadded cable some or all of the conductors are arranged in quads, or groups of two pairs. A cable containing 26 or more pairs of conductors is color-coded according to groups, to simplify matching for splicing. "Composite" means that the cable contains conductors of two or more sizes.

Building and Switchboard Cable

Building and switchboard cable is used to make connection with the service conductors, and to connect the switchboard apparatus to the main distribution frame. It may also be used for local wiring in the switchboard.

Switchboard cable is made up of copper, or tinned copper, conductors with a silk and cotton insulation—but it is also available with black enamel insulation. Pairs of conductors are usually bound together with a spiral layer of paper, a layer of lead tape, another layer of paper, and a fireproofed braid. For color-coded cable the insulation is colored according to a standard color scheme, so that each pair of wires and each unpaired single wire can be identified.

Plastic-Covered Cable

Plastic-covered cable has the advantage of being light in weight, which makes it especially suitable for advanced-base use. Another advantage is the fact that plastic is much cheaper than lead.

TYPES OF TELEPHONE CABLE SPLICES

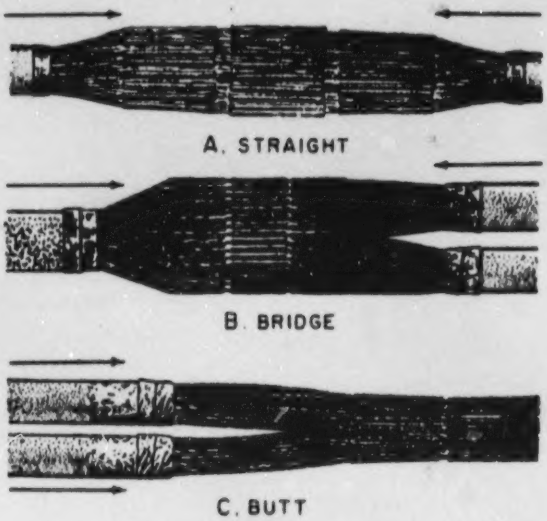
The three most commonly used types of telephone cable splices are the "straight" splice, the "bridge" splice, and the "butt" splice (fig. 12-1).

In figure 12-1A the cables come from opposite directions, the splice in each individual wire being covered by a small cotton "sleeve." In figure 12-1C the wires enter the sleeves from the same direction. In figure 12-1B, however, two cables coming from one direction have been spliced to a single cable coming from the opposite direction.

Straight splicing (fig. 12-1A) is the simplest form of splicing, consisting as it does of joining two wires that approach the splice point from opposite directions. Bridge (sometimes called "branch") splicing (fig. 12-1B) usually consists of splicing a branch into a main cable. Butt splicing (fig. 12-1C) is usually done to attain flexibility; a butt splice is often later changed to a straight or bridge splice.

SPLICING LEAD-SHEATHED CABLE

Most of your splicing will consist of the splicing together of opposing individual wires—that is, of straight splicing. This course will describe step-by-step the process of splicing the single conductors that make up two cables, of drying out the completed splice, and of "beating in" or "finishing" the lead sleeve used to cover the splice area. These procedures are fundamental to all three common types of telephone-cable splices.



73.192

Figure 12-1.—Types of telephone cable splices.

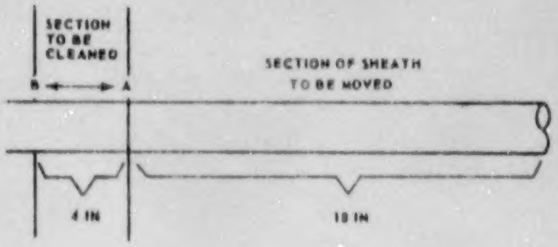
The procedural steps involved are:

1. Removing a section of the sheath from each cable-end.
2. Removing any metal protector on the cable core.
3. Selecting the correct individual wires from each cable.
4. Splicing the individual wires in a staggered pattern.
5. Covering each splice with a cotton sleeve to prevent contact between wires.
6. Placing an overall lead sleeve on the completed splices.
7. Beating in the lead sleeve to make a tight joint.
8. Wiping the joint.

The following sections explain each of these steps in detail.

REMOVING THE SHEATH

Measure the length of the sheath to be removed, and ring the cable at the point where the cut is to be made. The diagram in figure 12-2 shows a distance of 18 inches, but this is only by way of illustration. In every case the



73.193
Figure 12-2.—Preparing cable for splicing.

length of the splice opening will depend on (1) the size of the cable (in terms of number of pairs of wires), (2) the diameters of the conductors, and (3) the type of splice being made.

In ringing the cable be sure, as with power cable, that the cut or score does not penetrate completely through the sheath. A too-deep cut may damage the conductors, and a properly shallow cut "bells" the sheath, as desired, when the section to be removed is pulled off.

Clean the sheath back from the ringed point (distance AB in figure 12-2), and clean this area thoroughly. If dull or dark streaks are left they will not tin properly when the joint is wiped later, and the joint will be defective. On new cable use a file as a cleaner. On old cable a shave hook is better.

Immediately upon cleaning this area, and before your hands have touched it, coat it with stearine, and wrap it with a double layer of boiled-out muslin. You do this to protect the area while you are removing the adjacent length of sheath for the splice opening.

You split the sheath with a hacking (also called a "chipping") knife as described for power-cable splicing in chapter 10. You must avoid cutting through the paper wrapping of the cable core, so be careful in driving the knife under the edge of the split to loosen the sheath.

Grasp the cable at the section where you wrapped it in the protecting layer of muslin, and gradually work off the split portion of the sheath. It should break off at the ringed point.

Figure 12-3 shows the main steps in removing the sheath, with the exception of the muslin wrapping of the stearine-coated area, which is not shown but should be done as previously described.

When the sheath has been broken off, inspect the broken-off edges on the cable-ends to ensure that they are smooth. Any sharp edges or burrs could cause damage to the conductor insulation during splicing. The best way to guard against this is to butt the sheath edges with boiled sleeving muslin, or cotton tape as shown in figure 12-4.

USE OF SLEEVES

The splice on a pair of individual wires is covered with a small-diameter cotton or plastic sleeve. The whole splice—that is, the bundle of spliced individual wires—is covered with a larger-diameter lead sleeve.

It is advisable to slide the overall lead sleeve onto one of the cables as soon as the section of sheath has been removed and the cable end has been cleaned. Slip the sleeve up the cable far enough to have it out of your way as you perform the individual-wire splicing operations. When all the wire splices have been completed, you can draw the sleeve down over the bundle.

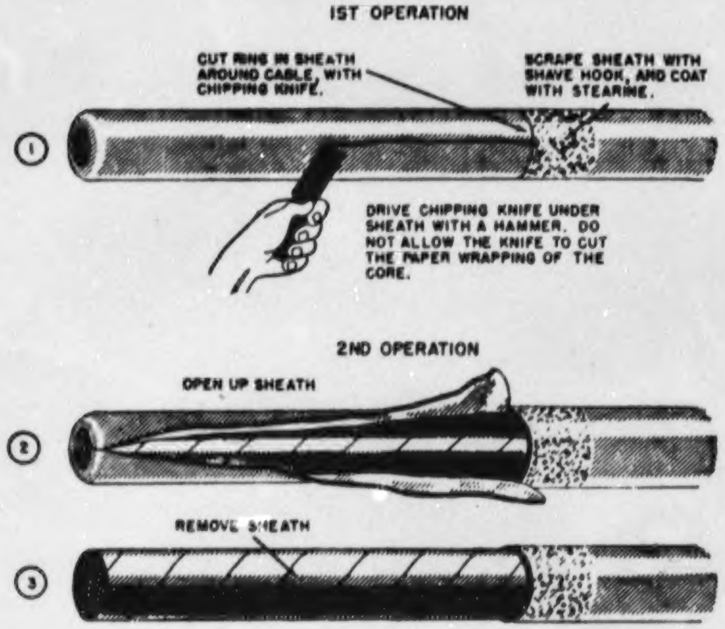
Before you slide the lead sleeve on, inspect it for cleanliness and for sharp edges. If necessary, smooth up the ends with a lead file.

The size of the lead sleeve will depend on the size of the cable, the diameters and number of the wires, and the type of splice. The size of a cotton or plastic sleeve depends on the diameter of the spliced wires it covers.

BOILING OUT INSULATION

"Boiling out" is a term used to refer to a procedure for removing any moisture which may be present in the insulation. Besides removing moisture and preventing the same from reentering the break, boiling out makes it easier for you to remove the paper insulation from individual wires when you are ready to splice them.

Boiling out consists of pouring hot paraffin over the sheath, starting about 6 inches back from the exposed wires, and gradually working the stream of paraffin onto the paper insulation and out to the ends of the wires. The temperature of the paraffin should not exceed 375° F—temperature higher than 390° F will damage the paper insulation. If you do not have a thermometer capable of registering such high temperature, you can apply a practical test to the paraffin when it is heating. Watch the dry ring that forms and gradually creeps up on the outside of the pot. This ring will begin to form when the paraffin is at about 360° F. When the ring is about 2 inches wide, the paraffin is at about correct working temperature.


1ST OPERATION
CUT RING IN SHEATH AROUND CABLE, WITH CHIPPING KNIFE.
SCRAPE SHEATH WITH SHAVE HOOK, AND COAT WITH STEARINE.
①
DRIVE CHIPPING KNIFE UNDER SHEATH WITH A HAMMER. DO NOT ALLOW THE KNIFE TO CUT THE PAPER WRAPPING OF THE CORE.
2ND OPERATION
OPEN UP SHEATH
②
REMOVE SHEATH
③

① *Using chipping knife.* ② *Opening sheath.* ③ *Sheath removed.*

73.194

Figure 12-3.—Steps in removing sheath.

The paraffin, as it cools and hardens, forms a seal which excludes the entrance of moisture. When you are splicing large cable, it is advisable to repeat boiling out as soon as you have spliced 200 pairs of wires. The reason is that by the time you have spliced the 200 the insulation will have begun to absorb moisture from your hands and from the atmosphere. Another boiling out will remove this moisture and reseal the insulation.

If the splice is left incomplete overnight, or if you are working in a very damp atmosphere, you may have to go through the boiling-out process several times. Discoloration of the insulation and a bluish-green discoloration of the conductors are sure signs that excessive moisture is present. If only a small amount of moisture had seeped in, the insulation, but not the conductors, will be discolored.

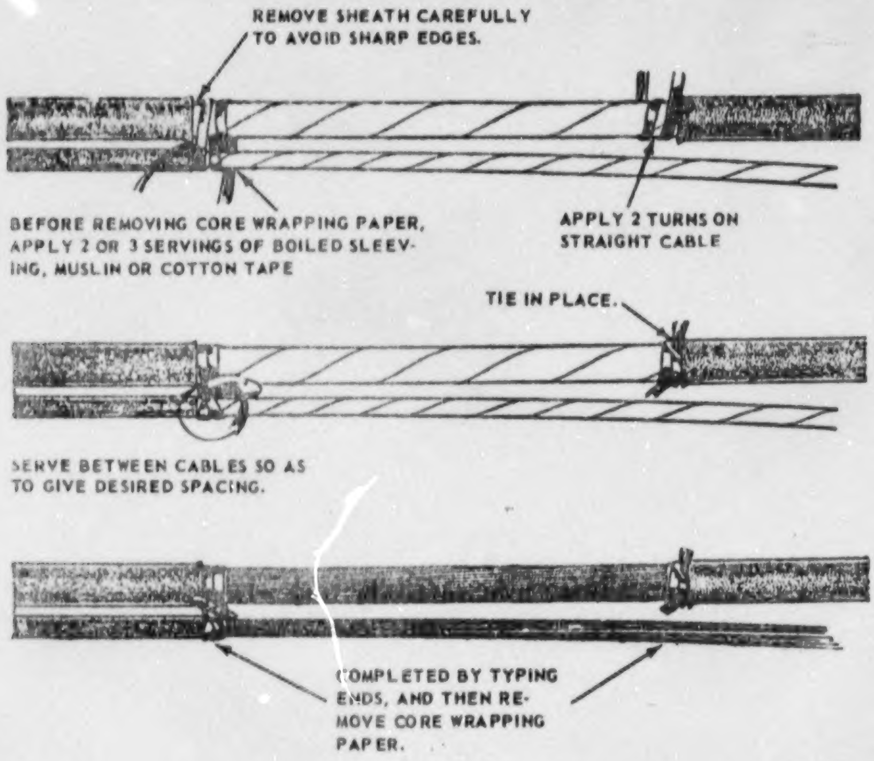
DRYING BY DESICCANT

The paraffin boiling-out method of drying has several disadvantages. These include fire hazard, objectionable fumes, possible burns to personnel, and splashes of hot wax on floors or walls. The method of drying by the use of a "desiccant" (drying agent) is therefore often used instead. The usual desiccants employed are anhydrous calcium sulfate and silica gel. Hot paraffin drives out moisture. A desiccant, on the other hand, absorbs it.

If a desiccant is available, you sprinkle it in generous amounts all over the conductors after the wire work (splicing and sleeving) is completed. First, however, you enclose the splice bundle in a muslin envelope, long enough to overlap at both ends of the splice. Open one end of this envelope, and let the desiccant trickle in. Spread the wires apart with your fingers to allow good penetration.

SPLICING THE WIRES

The pairs of wires are arranged within a cable in color groups, with the low count at the center of the core and the higher count outside. This arrangement assists in quick identification.


REMOVE SHEATH CAREFULLY TO AVOID SHARP EDGES.
BEFORE REMOVING CORE WRAPPING PAPER, APPLY 2 OR 3 SERVINGS OF BOILED SLEEVING, MUSLIN OR COTTON TAPE
APPLY 2 TURNS ON STRAIGHT CABLE
TIE IN PLACE.
SERVE BETWEEN CABLES SO AS TO GIVE DESIRED SPACING.
COMPLETED BY TYPING ENDS, AND THEN REMOVE CORE WRAPPING PAPER.

73.195

Figure 12-4.—Butting the sheath.

However, you should always work from a splicing diagram, or at least from definite identification instructions.

Lash the cable ends into convenient adjacent position, and fold the wires back as shown in figure 12-5A. Next, grasp a pair of wires from the right-hand cable end, the corresponding pair from the left-hand end, and give them a half-turn as shown in figure 12-5B. Then, holding both pairs of wires in one hand, cut them about 4 to 4 1/2 inches from the turn, as shown in figure 12-5C.

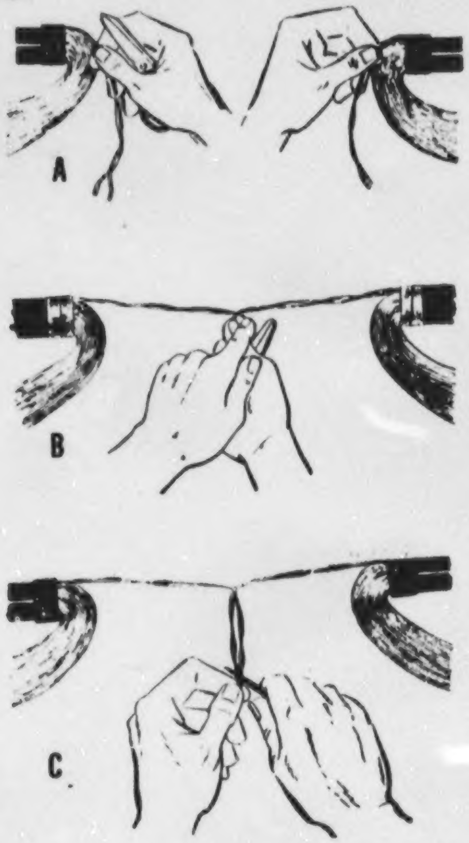
Before the splice can be made, the insulation must be stripped from the lengths of wires beyond the turn. As shown in figure 12-6, you grasp the wires just below the turn and pull the insulation off the ends. It is best to pull away from the turn and slightly toward the side on which you plan to slip the cotton sleeve. This will prevent the ends of the wires from curling.

Next you fit cotton sleeves onto both wires at the same time, by taking a pair of sleeves, waxed and ready for use, and slipping them over the wires. Use a rotating motion to slide the sleeves up to a position where they will not interfere with the splicing procedure.

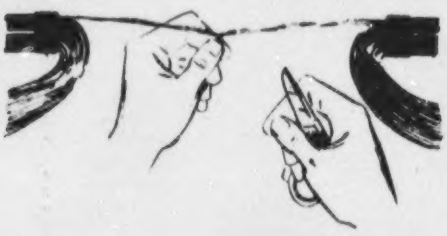
Now bend one wire of each pair back out of the way and draw the other wires of each pair together as shown in figure 12-7. Draw the wires close together, so that the splicing twist can be made close to the ends of the insulation. Then make the "crank-handle twist" shown in figure 12-8. First roll the left-hand wire over the right-hand one. Then bend them at right angles, and twist them together with a cranking motion of your wrist, until you get a twist about 1/2 inch long.

Bend of twist the "pigtail," and cut off the excess wire. Then slip the sleeve down over the joint, as shown in figure 12-9.

It is, of course, vitally important that you know what wires go together, and you are supposed to have a diagram or definite instructions with regard to this. However, it is always

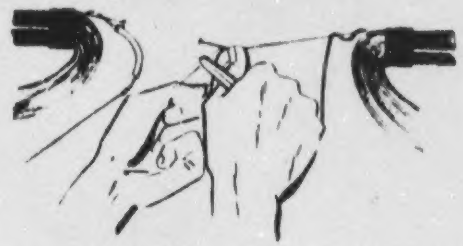


73.196
Figure 12-5.—Joining a pair of wires.

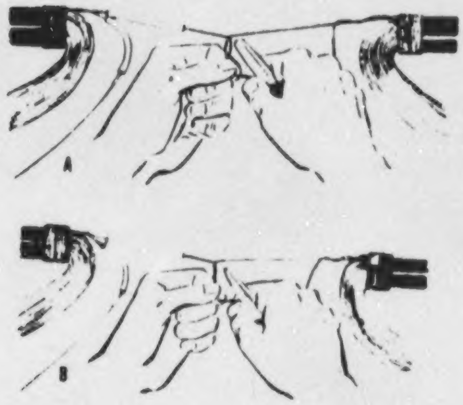


73.197
Figure 12-6.—Stripping insulation from wires.

possible that you may have to do an emergency job where you don't have the necessary information in advance. In a case of this kind a knowledge of the arrangement of grounds in a cable will be of great value.



73.198
Figure 12-7.—Drawing wires together for splicing.



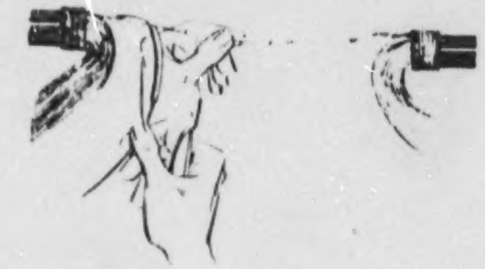
73.199
Figure 12-8.—Twisting the wires.

CONDUCTOR IDENTIFICATION

Conductor identification is predicated upon the establishment of a pair count. This operation is indispensable to the proper testing and splicing of telephone cable. Three considerations are involved in the count; the relative position of cable and central office, geometric pattern, and, tracer pairs.

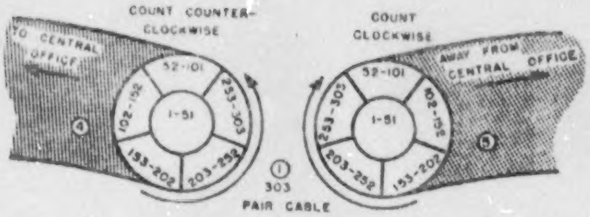
Position of Cable and Central Office

The first consideration in the establishment of the count is the relative position of the central office and the cable end to be spliced. If the exposed end faces away from the central office, the count is made in a counterclockwise direction. If the exposed end faces toward the central office, the count is made in a clockwise direction (fig. 12-10A).



73.200

Figure 12-9.—Slipping the sleeve over the splice.



73.201.1

Figure 12-10A.—Cable conductor groups, 303 pair cable.

Geometric Pattern

Cable may contain various quantities and combinations of geometric patterns (12-10B). The count begins at the center of the core and proceeds to the sheath in a clockwise or counterclockwise direction.

As an aid in establishing or determining identification of pairs, the cable cores are color coded by layers or groups bound separately by colored spirally wrapped soft textile binders or markers.

A group of 25 pairs has been selected as the most suitable size for a uniform group, and all standard size cables, except those smaller than 25 pairs, can be divided by this number. The pairs within the 25-pair groups are identified by a simple code that use 10 colors, 5 for tip and 5 for ring, with no duplication. The 25-pair groups (Table 12-2) are bound with bicolor binders which follow the 5 + 5 color code used for pairs.

Tracer Pairs

The core of non-polyethylene insulated cable contains certain distinctively colored conductors known as tracers. A tracer pair is used by the splicer to establish a talking pair to his helper at the distant end of a length of cable being spliced at a terminal or at the main distribution frame in a central office. Terminated tracers are connected to the highest number terminal for that cable or group. A 101 pair terminal would have the tracer terminated on pair 101.

PLACING AND WIPING LEAD SLEEVE

When all the pairs of conductors have been spliced, you are ready to slip the lead sleeve over the completed splice bundle. Take care in sliding the sleeve not to disturb the cotton sleeves on the individual wire splices. If these are moved, the separate wires may come into contact.

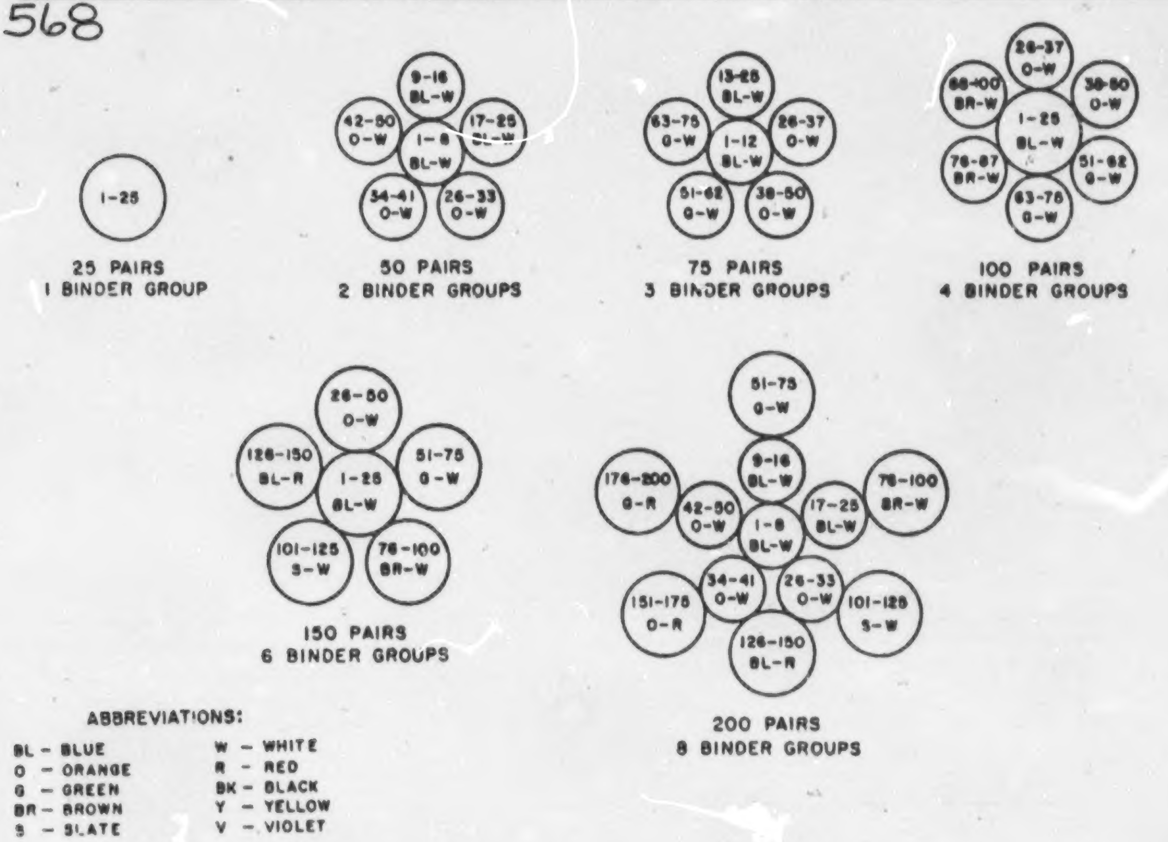
Before you slide the sleeve into place, wrap the splice bundle with two layers of boiled-out muslin as shown in figure 12-11.

Unless you made your individual splices neatly and compactly, and unless you staggered them so as not to have them all at the same point, you will have difficulty getting the sleeve over the splice bundle.

The procedure for wiping the lead sleeve is the same as that described for a sleeve on a power cable in chapter 10.

SPLICING SILK AND COTTON INSULATED CABLE

Paper ribbon or paper pulp insulation has certain disadvantages which make it unsuitable for use on cables to be connected to distribution frames, terminal strips, and other interior terminal points. The cause is the fact that the paper insulation is not strong enough to withstand the amount of handling required to make connections. In working the core into a form


1-25
25 PAIRS
1 BINDER GROUP
9-16
BL-W
42-50
O-W
1-8
BL-W
17-25
BL-W
34-41
O-W
26-33
O-W
50 PAIRS
2 BINDER GROUPS
13-25
BL-W
63-75
G-W
1-12
BL-W
26-37
O-W
51-62
G-W
38-50
O-W
75 PAIRS
3 BINDER GROUPS
26-37
O-W
88-100
BR-W
38-50
O-W
1-25
BL-W
76-87
BR-W
51-62
G-W
63-75
G-W
100 PAIRS
4 BINDER GROUPS
26-50
O-W
126-150
BL-R
1-25
BL-W
51-75
G-W
101-125
S-W
76-100
BR-W
150 PAIRS
6 BINDER GROUPS
51-75
G-W
9-16
BL-W
176-200
G-R
42-50
O-W
1-8
BL-W
17-25
BL-W
76-100
BR-W
34-41
O-W
26-33
O-W
151-175
O-R
101-125
S-W
126-150
BL-R
200 PAIRS
8 BINDER GROUPS
ABBREVIATIONS:
BL - BLUE
O - ORANGE
G - GREEN
BR - BROWN
S - SLATE
W - WHITE
R - RED
BK - BLACK
Y - YELLOW
V - VIOLET

73.201.2

Figure 12-10B.—Core makeup of polyethylene-insulated conductor cables.

which is fanned out and laced, the paper insulation, which is not baked on, will unroll. Besides, paper insulation deteriorates on exposure to air, and its dielectric strength falls off considerably on exposure to moisture.

It is the custom, therefore, to splice incoming paper-insulated cable onto short lengths of lead-covered textile-insulated (silk or cotton insulated) cables called cable "heads." The heads are used to make the direct connections with central office distribution frames and terminal strips.

Prepare silk and cotton insulated cable for splicing by boiling out with beeswax, or with a special petroleum wax. Do not use paraffin, because it discolors the textile insulation, and makes it very difficult for the operator to separate conductors for fanning, forming, and splicing. On the other hand, do not use beeswax on paper-wrapped insulation, because it will make the paper brittle and may cause breakage.

Start pouring the wax a few inches back on the sheath, and gradually advance toward the exposed conductors. To start at the conductors and go the other way would defeat the purpose of boiling out by forcing any moisture under the sheath further back.

The same standard splice openings, number of cotton sleeve banks, and splicing procedures apply to textile-insulated exchange cables as apply to paper-insulated exchange cables. When splicing silk and cotton insulated cable to paper-wrapped insulated cable, use a desiccant for drying out the joint.

Mark the point for removal of textile insulation by the same procedure described for paper-insulated cables. Cut off the conductors 4 1/2 inches from the end and use long-nosed pliers

Table 12-1.—Color Code for Plastic-insulated Conductor Cables.

Pair No.	Group binder		Color of insulation	
			Tip	Ring
1	Blue	White	White	Blue
2	Blue	White	White	Orange
3	Blue	White	White	Green
4	Blue	White	White	Brown
5	Blue	White	White	Slate
6	Blue	White	Red	Blue
7	Blue	White	Red	Orange
8	Blue	White	Red	Green
9	Blue	White	Red	Brown
10	Blue	White	Red	Slate
11	Blue	White	Black	Blue
12	Blue	White	Black	Orange
13	Blue	White	Black	Green
14	Blue	White	Black	Brown
15	Blue	White	Black	Slate
16	Blue	White	Yellow	Blue
17	Blue	White	Yellow	Orange
18	Blue	White	Yellow	Green
19	Blue	White	Yellow	Brown
20	Blue	White	Yellow	Slate
21	Blue	White	Violet	Blue
22	Blue	White	Violet	Orange
23	Blue	White	Violet	Green
24	Blue	White	Violet	Brown
25	Blue	White	Violet	Slate
26	Orange	White	White	Blue
50	Orange	White	Violet	Slate
51	Green	White	White	Blue
52	Green	White	White	Orange
74	Green	White	Violet	Brown
75	Green	White	Violet	Slate
76	Brown	White	White	Blue
77	Brown	White	White	Orange
99	Brown	White	Violet	Brown
100	Brown	White	Violet	Slate

73.338

Table 12-2.—Binder Markings for 25 Pair Groups.

Group No.	Color of Bindings	Group Pair Count
1	White-Blue	1 - 25
2	White-Orange	26 - 50
3	White-Green	51 - 75
4	White-Brown	76 - 100
5	White-Slate	101 - 125
6	Red -Blue	126 - 150
7	Red -Orange	151 - 175
8	Red -Green	176 - 200
9	Red -Brown	201 - 225
10	Red -Slate	226 - 250
11	Black-Blue	251 - 275
12	Black-Orange	276 - 300
13	Black-Green	301 - 325
14	Black-Brown	326 - 350
15	Black-Slate	351 - 375
16	Yellow-Blue	376 - 400

73.250

to crush the silk/cotton insulation at the marked point. Don't apply too much pressure, because this will fatten the conductor and may cause it to break after splicing. After the insulation has been crushed, it can be removed by decreasing the pressure on the pliers and "skinning" the insulation off by pulling toward the end in a straight line. However, if you prefer you can pull it off with the fingers. Never use the back of the splicing scissors to remove insulation; this might break the relatively brittle tinned-copper conductors in a textile-insulated cable.

Some textile-insulated cables have enameled conductors, and this enamel must be thoroughly removed before the wires can be spliced. One method is by light scraping between the jaws of long-nosed pliers—but you must be extremely careful not to nick or flatten the wires.

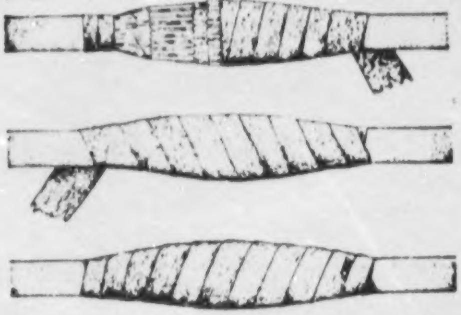
A good tool for scraping enamel is the wire scraper, which consists of a steel spring 3/4 inch wide, bent in the form of a U and with ends turned and sharpened. As you gain skill with this tool, you will find it effective for removing silk, cotton, or plastic insulation.

Twist the conductors by using the same twist described for splicing paper-insulated cable. After the splice is completed, boil out with hot paraffin or dry with desiccant as you would a paper-insulated splice.

SPLICING BURIED CABLE

Buried service cable is generally used for substation underground service connections. The cable is usually one-pair or two-pair lead-covered rubber-insulated cable to which a protective covering of paper, jute, or steel tape has been added.

570



73.202

Figure 12-11.—Wrapping the splice.

In some cases there may be power cable in the same trench with the telephone cable (the two must be at least 6 inches apart). You must check on the possibility of this, and be sure you are working on the correct cable, before you make any sheath openings.

Splices are made at manholes, handholes, pedestals, or buried splice joints.

Plan the splice layout carefully, to avoid unnecessary removal of protective covering. Remove all dirt adhering to the covering before you slide the lead sleeve over the cable. When the splice is completed and the joint wiped, paint the lead sleeve, the wiped joint, and the exposed cable sheath with a protective compound, such as Ozite B, and wrap the whole section in three layers of black friction tape or muslin.

LEAD-COVERED CABLE REPAIR

Making minor repairs because of ring cuts, sheath breaks, lightning burns, bullet holes, or other damage to small aerial cable is part of your job. Such damage can be repaired by the carbon-electrode welding method or with an acetylene torch. The carbon-electrode method is preferable if damage extends through the sheath and moisture has reached the conductor insulation. The acetylene-torch method is preferable for damage which does not extend through the sheath.

Water-soaked paper insulation usually causes pairs to become shorted. It follows that shorted pairs are frequently an indication that somewhere the sheath is damaged enough to allow moisture to penetrate to the insulation.

Steps in making a sheath-damage repair are as follows:

1. Open and spread the sheath.
2. Dry out the insulation with desiccant.
3. Repair any charred, corroded, or otherwise deteriorated insulation.
4. Test the cable pairs before preparing to close the sheath.
5. Close the sheath.
6. Solder the seam and restore cable hangers to appropriate spacings.

Opening the Sheath

After the fault has been located and the ladder or splicing platform has been placed for gaining access to the repair point on the cable, proceed to open the sheath as follows:

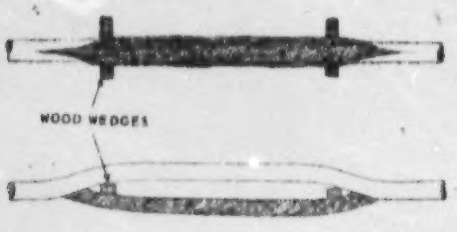
1. Straighten the cable if necessary, and reduce cable tension, also if necessary, by placing grade clamps.
2. Use a wire brush to brighten the lead sheath in the section to be split.
3. Rub stearine along the cable where the lengthwise split is to be made. As the cut is made, continue to lubricate with stearine.
4. Split the cable with a "cable stripper," a cutting tool with small and large blades which can be set to cut a given depth. Adjust the small blade of the stripper so that it will penetrate 1/32 to 1/16 inch. Make the starting cuts with the small end of the blade, routing out the small lead shavings as you cut. After a definite line of cut has been established, turn the stripper over and use the large end of the blade to bevel the cut. Do not cut all the way through the sheath with the large end. Just before the blade is about to break through the sheath, reverse the tool and complete the cut with the small end.
5. After you have cut through the sheath, open it with a pair of cable pliers. Grasp the handles of the cable pliers firmly and open the incision on one side. With the sharp jaw in the cut, work the pliers sideways, exerting a small downward pressure at the same time. Bend the sheath cautiously, so as not to deform it. When one side of the sheath is bent back, repeat the process on the other side.

When the sheath has been opened, push out the cable by inserting wooden wedges between sheath and cable as shown in figure 12-12.

Making Wire Repairs

If wires must be spliced, the cut must be long enough so that splices can be properly staggered. Apply paper tape to any points at

716



73.203
Figure 12-12.—Wedging section of cable out of opened sheath.

which the wire is sound but the insulation has become blackened because of electrolytic action. To apply the tape, pull the pair out and cut a piece of tape long enough to extend at least 1/2 inch beyond the corroded portion. Press it down with your fingers, and trim off the excess. In hot weather take great care that perspiration from your hands does not dampen the insulation.

After all damaged wires are repaired, push cotton tape under the edges of the sheath with a butting tool. Wrap the [illegible] with 1-inch tape which has previously been [illegible]ed out in paraffin, and then push the core back into the sheath. Test the cable pairs to ensure that all trouble is cleared.

Closing the Sheath

Before closing the cut in the sheath, cut a piece of press board about 5/16 inch wide and as long as the length of the opening. Lubricate with stearine generously, so that the edges of the sheath will close readily around the press board strip, and place the strip under the opening after removing the wedges and pushing the cable back into the sheath. Use tongs to press the lead sheath back into its original shape. It is not necessary to close the cut completely, but if it is left partly open, the strip of press board should cover the cable so that it will not be damaged during the process of sealing up the split in the sheath.

In closing the sheath you should work the same into shape gradually. First squeeze it together with your hands, then shape it into its original shape by applying pressure with tongs kept lubricated with stearine. Do not roll the tongs over the sheath, because this will create depressions around the circumference. Take care, also, not to apply pressure directly over the cut until the cable is well shaped, or you may flatten the cable.

Soldering the Seam

After the sheath has been closed over the cable so that the edges of the cut are from 1/8 to 1/4 inch apart, use the scoring tool and a wire brush to clean the sheath thoroughly. Apply pasters along the edges and ends of the cut, to fix the width and length of the closing seam. Set the pasters about 1/16 to 1/8 inch away from the edges of the cut. Use a halfround bastard file at each end of the cut to form a depression into which solder can be flowed to seal any fine cracks caused by bending back the sheath. After the pasters are set, apply stearine to the portion to be soldered.

Fuse stearine core solder to the cut by holding the end of the solder bar in contact with the sheath and touching the solder with the edge of the beveled end of the electrode. In this manner coat the entire area to be soldered, but use only the minimum amount of solder. Heat and manipulate the deposited solder with the beveled surface of the electrode, so as to tin the entire area of the seam. To ensure thorough tinning, turn the electrode so the edge of the beveled surface can be moved along inside the cut.

Light contact and a circular motion of the electrode on the solder will aid in raising the temperature of the solder so that the tinning can be accomplished to best advantage. Additional solder should be flowed into the seam to fill it to the top. Move the electrode over the patch to remove air bubbles and flux, and to smooth the surface.

After completing the welding, remove the pasters and use a lead file to smooth off any rough spots in the seam. Smooth finally with a wire brush.

Repairs with Acetylene Torch

Small sheath defects, which do not extend through such as ring cuts and cracks, can be repaired by acetylene torch. Acetylene, however, is a highly flammable gas which is explosive in confined spaces. Consequently, never use the acetylene torch for making repairs in a manhole or other enclosed space. Before you use an acetylene torch (operating instructions come with the torch, be sure you fully understand its operation and, particularly, the safety precautions that go with it.

To make sheath repairs with an acetylene torch you again use stearine core solder. Thoroughly clean the area around the defect with a brushing motion. Apply the torch flame to the cleaned area, being careful not to concentrate long on one spot. Apply solder over the area of the defect, using sufficient heat to tin thoroughly. Build up enough solder to fill the crack or depression. Use a small finishing cloth to pack the solder into the defect, and to smooth off the patch so that it is only slightly more than flush with the surface of the sheath. A repair should extend from 1/4 to 1/2 inch beyond the defect.

Never keep the torch lighted except when making repairs. If spots to be repaired are close together, you may move from one to the other without extinguishing the torch, if you don't have to change position radically. However, if you have to change position or pass a pole, turn off the torch, and relight again in the new position.

SPLICING POLYETHYLENE-INSULATED CABLE

Polyethylene-insulated cable (PIC) (polyethylene is commonly called "plastic") is available as aerial or as direct burial cable, both types being made in even-number pairs. The cores of both types are identical, in that they are fully coded—meaning that each pair in the cable is distinguishable by color from every other pair. The is accomplished by the use of a color scheme which provides different colors of insulation for each pair in a 25-pair group, together with colored or imprinted bindings to distinguish 25-pair groups from each other. By referring to tables which give pair color codes, binder markings and possible layups, you can match the wires in one of these cables with little difficulty. See Table 12-3.

PIC has solid copper conductors, each with polyethylene insulation of the required color. The insulated conductors are twisted into pairs. The required number of pairs are stranded into a cable core and enclosed in a metallic shield and polyethylene jacket or sheath.

In cables having 25 pairs or less, the twisted pairs are assembled to form a substantially cylindrical core. In cables having more than 25 pairs, the twisted pairs are arranged in groups, each group being bound by moisture-resistant thread or tape. Each group contains not more than 25 pairs. For layup purposes, the basic 25-pair groups may be divided into two or more subgroups called units.

Each unit in a particular 25-pair group is enclosed in bindings of the colors indicated for its particular 25-pair group. For example: suppose you have a 100-pair cable and are looking for pair number 88. You look for the group with binding colors white and brown, then look for the pair in that particular group with black and green insulation (fig. 12-10B and Table 12-1).

The aerial-type cable has an aluminum shield applied longitudinally over the core covering. The seam in this shield is joined during the manufacturing process by means of a cold weld, an electric weld, or soldering with a non-acid flux. A polyethylene jacket is then placed over the shield.

The direct-burial type cable has two polyethylene jackets with a copper shield between the inner and outer jacket. The inner jacket is placed over the completed core, and is from 50 to 70 mils thick according to the number of pairs in the cable. The outer jacket placed over the shield, is from 40 to 80 mils thick.

SPLICING AERIAL-TYPE CABLE

The procedure for splicing polyethylene-sheathed telephone cable varies according to whether the cable is aerial or for direct burial. There is also a procedure for splicing polyethylene-sheathed cable to lead-sheathed cable. In any case, however, a splice in this cable is enclosed in a butyl-rubber "closure unit" consisting of a base assembly and a rubber cover which snaps in place over it.

Removing the Sheath

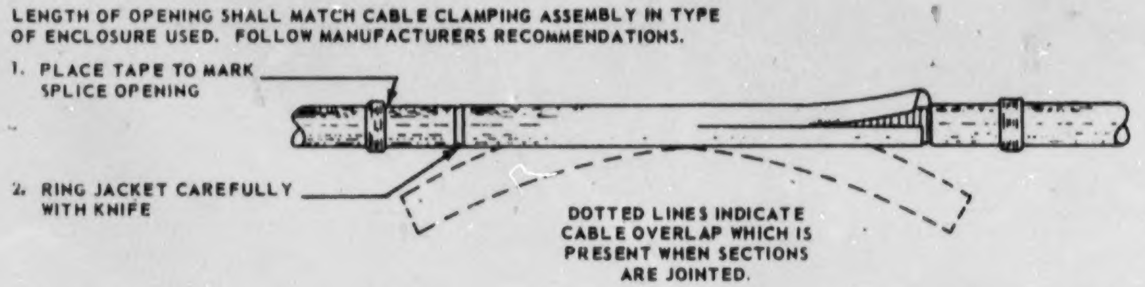
The length of the opening in the cable sheath varies according to the type of closure and the size of the cable. Manufacturer's instructions on this point should be followed. Steps in removing the sheath are as follows:

1. After determining the length of the opening from the manufacturer's instructions, place three wraps of vinyl tape around the sheath at each end of the proposed opening to mark the ends, as shown in figure 12-13.
2. Ring the sheath carefully 3 inches from the splice opening marker tapes, as also shown in figure 12-13.

Table 12-3.—Possible Lay-ups of Polyethylene Insulated Cables with Standard Telephone Color Code.

Size	Center			First Layer			Second Layer		
Pairs in Cable	Pairs in Unit	Binder Colors	Pair Count	Pairs in Unit	Binder Colors	Pair Count	Pairs in Unit	Binder Colors	Pair Count
50	8	White-Blue	1-8	9	White-Blue	9-17			
				8	White-Blue	18-25			
				8	White-Orange	26-33			
				9	White-Orange	34-42			
				8	White-Orange	43-50			
75	12	White-Blue	1-12	13	White-Blue	13-25			
				12	White-Orange	26-37			
				13	White-Orange	38-50			
				12	White-Green	51-62			
				13	White-Green	63-75			
100	25	White-Blue	1-25	12	White-Orange	26-37			
				13	White-Orange	38-50			
				12	White-Green	51-62			
				13	White-Green	63-75			
				12	White-Brown	76-87			
				13	White-Brown	88-100			
150	25	White-Blue	1-25	25	White-Orange	26-50			
				25	White-Green	51-75			
				25	White-Brown	76-100			
				25	White-Slate	101-125			
				25	Red-Blue	126-150			
200	8	White-Blue	1-8	9	White-Blue	9-17	25	White-Green	51-75
				8	White-Blue	18-25	25	White-Brown	76-100
				8	White-Orange	26-33	25	White-Slate	101-125
				9	White-Orange	34-42	25	Red-Blue	126-150
				8	White-Orange	43-50	25	Red-Orange	151-175
							25	Red-Green	176-200
300	25	White-Blue	1-25	25	White-Brown	76-100			
	25	White-Orange	26-50	25	White-Slate	101-125			
	25	White-Green	51-75	25	Red-Blue	126-150			
				25	Red-Orange	151-175			
				25	Red-Green	176-200			
				25	Red-Brown	201-225			
				25	Red-Slate	226-250			
				25	Black-Blue	251-275			
				25	Black-Orange	276-300			
400	25	White-Blue	1-25	25	White-Orange	26-50	25	Red-Orange	151-175
				25	White-Green	51-75	25	Red-Green	176-200
				25	White-Brown	76-100	25	Red-Brown	201-225
				25	White-Slate	101-125	25	Red-Slate	226-250
				25	Red-Blue	126-150	25	Black-Blue	251-275
							25	Black-Orange	276-300
							25	Black-Green	301-325
							25	Black-Brown	326-350
							25	Black-Slate	351-375
							25	Yellow-Blue	376-400

73.251


LENGTH OF OPENING SHALL MATCH CABLE CLAMPING ASSEMBLY IN TYPE OF ENCLOSURE USED. FOLLOW MANUFACTURERS RECOMMENDATIONS.
1. PLACE TAPE TO MARK SPLICE OPENING
2. RING JACKET CAREFULLY WITH KNIFE
DOTTED LINES INDICATE CABLE OVERLAP WHICH IS PRESENT WHEN SECTIONS ARE JOINTED.

73.204

Figure 12-13.—Splicing opening in polyethylene cable.

3. Remove the sheath between the two rings.

4. Remove the shield in the same area, as shown in figure 12-14.

5. Cut tabs in the jacket and shield in the 3-inch space between opening and marker tapes as shown in figure 12-15. Cut 3 tabs for cable up to 0.6 inch in diameter, 4 for cable from 0.6 to 1/6 inches in diameter, and 6 for cable from 1/6 inches to 2.2 inches in diameter.

6. Enlarge slots to 1/8 inch as also shown in figure 12-15.

7. Place two turns of vinyl tape, adhesive side out, then one turn with adhesive side in, as shown in figure 12-16. Push these wraps of tape under tabs as shown, to form a base for the clamps of the base assembly to be installed later.

8. Place two turns of vinyl tape to hold core wrapper in place at ends of tabs, and remove core wrapper.

Identifying Binder Groups

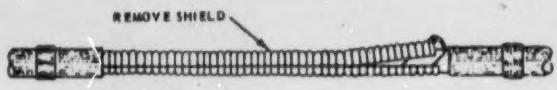
Upon removing the core wrapper, have ready some short pieces of paired conductors with colors matching the color code of the binder groups. Place a matching color pair around each binder group and pigtail the ends of the tie wires. The binder threads or tape can then be, removed from the binder groups.

Mount the base assembly for the ready-access closure. The tape which was placed to mark the splice opening may then be removed.

Place the groups in a convenient position, so you can proceed with splicing the conductors.

Splicing the Conductors

Figure 12-17 shows one method of splicing the conductors, a method which includes the use of a plastic-filled sleeve. This method requires that the wires first be twisted with three loose turns. Strip off the insulation and make five firm half-turns, cut off the excess wire leaving about 1 inch of twisted bare wires, and solder with resin core solder. Then slip the filled sleeve over the joint and bend the splice into position.



73.205

Figure 12-14.—Removing the shield.

Figure 12-18 shows the use of a sealing-type splicing connector. The conductors are twisted enough to hold the pair of wires together, and the connector is slipped over the ends of the wires approximately 3 inches from the beginning of the twist. A hand-operated crimping tool is used to crimp the connector. DO NOT remove the insulation from the ends of the wires when using this method, because the insulation on the wires keeps the conductors centered in the connector.

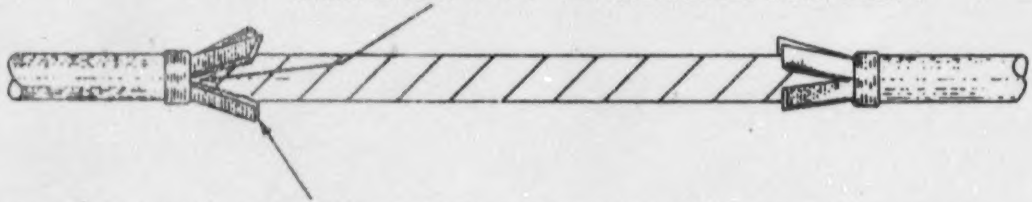
When a pair of conductors dead end in a splice, turn back 3/4 inch of one conductor and place a filled plastic sleeve over the end of the pair of conductors.

Layup of Spliced Conductors

The number of splice bundles required for a convenient layup will depend on the length of the splice opening and the size of the cable. The splices must be placed in uniform bundles and distributed so as to give a uniform shape

CUT TABS IN JACKET AND SHIELD. THREE FOR CABLES UP TO .6" DIAMETER, FOUR FOR CABLES UP TO 1.6" DIAMETER AND SIX FOR CABLES FROM 1.6" THRU 2.2" IN DIAMETER.

ENLARGE SLOT TO 1/8" TO ACCOMMODATE INNER CLAMP.

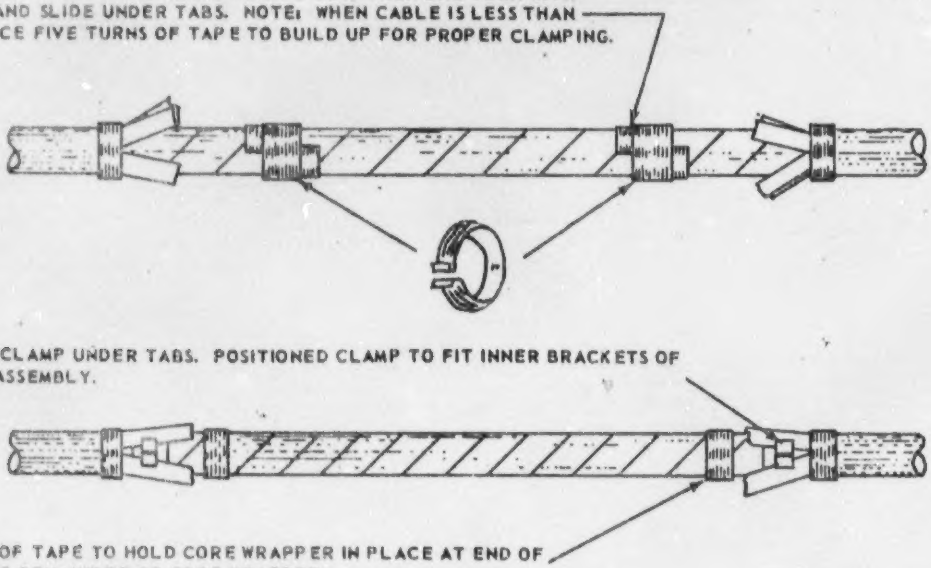


BEND TABS OUTWARD USING CARE TO AVOID DAMAGE TO SHIELD AND CORE WRAPPER.

73.206

Figure 12-15.—Cutting tabs in jacket and shield.

PLACE TWO TURNS OF VINYL TAPE, ADHESIVE SIDE OUT, THEN ONE TURN WITH ADHESIVE SIDE IN, AND SLIDE UNDER TABS. NOTE: WHEN CABLE IS LESS THAN .60" DIAMETER PLACE FIVE TURNS OF TAPE TO BUILD UP FOR PROPER CLAMPING.



SLIDE CLAMP UNDER TABS. POSITIONED CLAMP TO FIT INNER BRACKETS OF BASE ASSEMBLY.

PLACE TWO TURNS OF TAPE TO HOLD CORE WRAPPER IN PLACE AT END OF TABS, THEN REMOVE REMAINDER OF CORE WRAPPER.

73.207

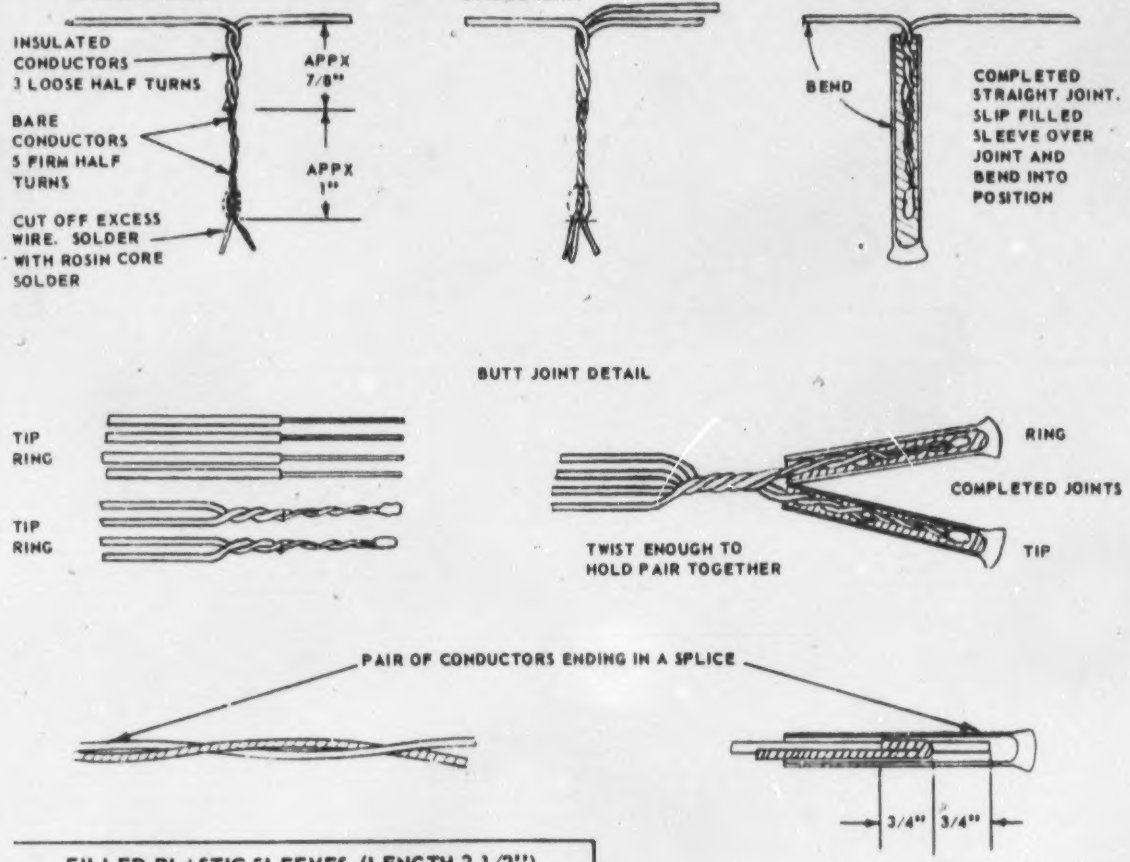
Figure 12-16.—Placing clamps under tabs.

to the full length of the splice area. After the bundle is completed, it should be bound with two layers of vinyl tape. Figure 12-19 shows a well-shaped splice bundle.

Closing the Splice

After the splices are complete and the bundles are taped, the closure is spread open, slipped over the splice, and snapped in place over the entire assembly. This closure is made of butyl rubber, and when it is placed over the splice assembly in the proper manner and fastened with the clips which come with the kit, the splice will be completely weatherproof, but still easily accessible should the need arise to reopen the closure.

Figure 12-20 shows two splice closures in place. The cables leaving the lower nipples run to terminal closures on other poles. Figure


STRAIGHT JOINT
INSULATED CONDUCTORS 3 LOOSE HALF TURNS
APPX 7/8"
BARE CONDUCTORS 5 FIRM HALF TURNS
APPX 1"
CUT OFF EXCESS WIRE. SOLDER WITH ROSIN CORE SOLDER
BRIDGE JOINT
BEND
COMPLETED STRAIGHT JOINT. SLIP FILLED SLEEVE OVER JOINT AND BEND INTO POSITION
BUTT JOINT DETAIL
TIP
RING
TIP
RING
RING
COMPLETED JOINTS
TIP
TWIST ENOUGH TO HOLD PAIR TOGETHER
PAIR OF CONDUCTORS ENDING IN A SPLICE
3/4"
3/4"

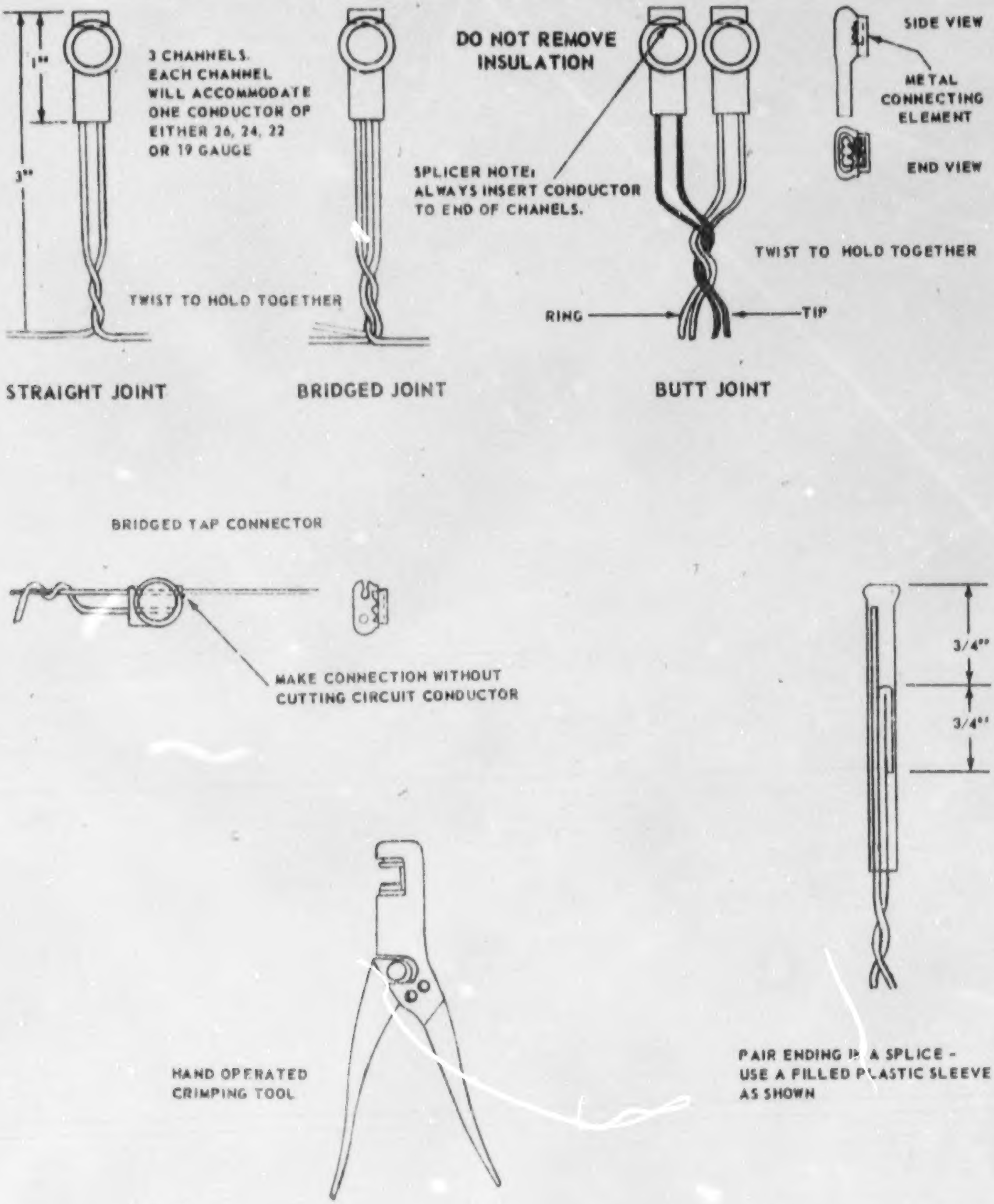
FILLED PLASTIC SLEEVES (LENGTH 2-1/2")			
GAUGE OF CONDUCTORS	TYPE OF JOINTS	INSIDE DIAMETER	COLOR
24X24	STRAIGHT	.085	YELLOW
24X22		.085	"
24X19		.105	GREEN
22X22		.105	"
22X19		.105	"
19X19		.125	CLEAR
24X24X24	BRIDGE	.085	YELLOW
24X24X22		.105	GREEN
24X24X19		.105	"
22X22X24		.105	"
22X22X22		.105	"
22X22X19		.125	CLEAR
19X19X24		.125	"
19X19X22		.125	"
19X19X19		.145	RED

TURN BACK ONE CONDUCTOR OF PAIR AND CAP WITH FILLED PLASTIC SLEEVE. POSITION SLEEVE FOR POSSIBLE FUTURE SPLICING.

PRECAUTION: TO AVOID CRACKING AND LOSS OF FILLER, THE PROPER SIZE SLEEVES SHOULD BE USED AND NOT FORCED OVER JOINTS.

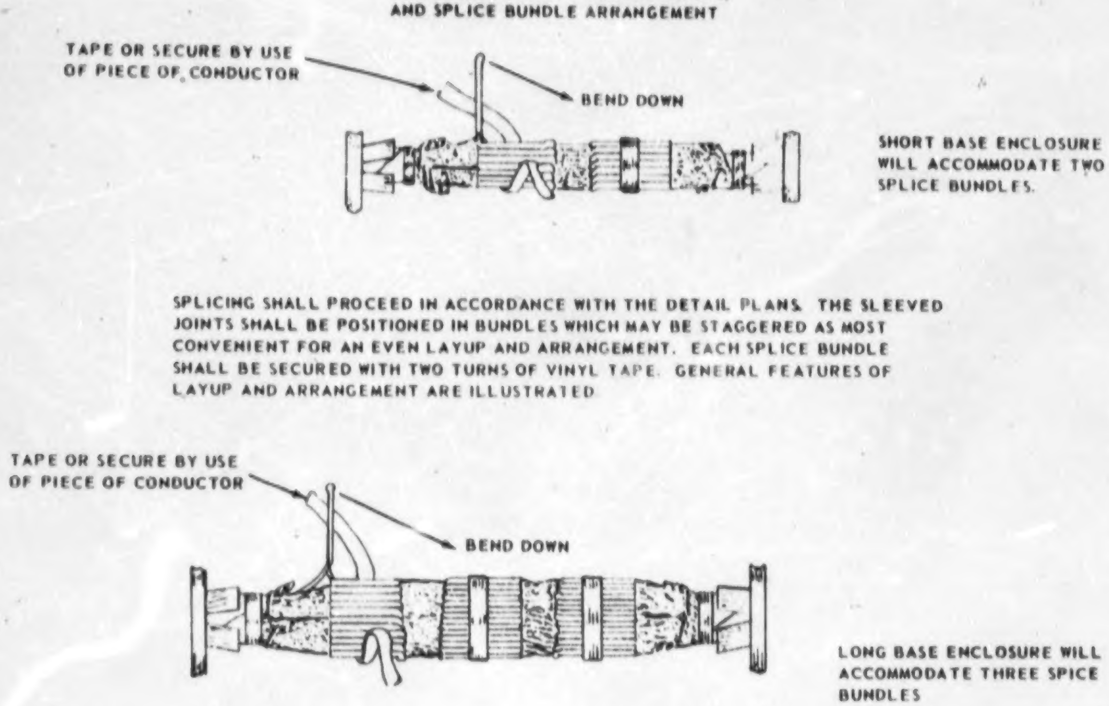
73.208

Figure 12-17.—Splicing details for various types of joints.


3 CHANNELS.
EACH CHANNEL
WILL ACCOMMODATE
ONE CONDUCTOR OF
EITHER 26, 24, 22
OR 19 GAUGE
1"
3"
TWIST TO HOLD TOGETHER
STRAIGHT JOINT
BRIDGED JOINT
DO NOT REMOVE
INSULATION
SPLICER NOTE:
ALWAYS INSERT CONDUCTOR
TO END OF CHANELS.
TWIST TO HOLD TOGETHER
RING
TIP
BUTT JOINT
SIDE VIEW
METAL
CONNECTING
ELEMENT
END VIEW
BRIDGED TAP CONNECTOR
MAKE CONNECTION WITHOUT
CUTTING CIRCUIT CONDUCTOR
3/4"
3/4"
HAND OPERATED
CRIMPING TOOL
PAIR ENDING IN A SPLICE -
USE A FILLED PLASTIC SLEEVE
AS SHOWN

73.209

Figure 12-18.—Sealing-type splicing connector.


UNIFORM LAYUP OF SLEEVED JOINTS, AND SPLICE BUNDLE ARRANGEMENT
TAPE OR SECURE BY USE OF PIECE OF CONDUCTOR
BEND DOWN
SHORT BASE ENCLOSURE WILL ACCOMMODATE TWO SPLICE BUNDLES.
TAPE OR SECURE BY USE OF PIECE OF CONDUCTOR
BEND DOWN
LONG BASE ENCLOSURE WILL ACCOMMODATE THREE SPICE BUNDLES

SPLICING SHALL PROCEED IN ACCORDANCE WITH THE DETAIL PLANS. THE SLEEVED JOINTS SHALL BE POSITIONED IN BUNDLES WHICH MAY BE STAGGERED AS MOST CONVENIENT FOR AN EVEN LAYUP AND ARRANGEMENT. EACH SPLICE BUNDLE SHALL BE SECURED WITH TWO TURNS OF VINYL TAPE. GENERAL FEATURES OF LAYUP AND ARRANGEMENT ARE ILLUSTRATED

73.210

Figure 12-19.—Layup pattern for splice.

12-21 shows the parts of a closure. When fewer than four cables are brought out the openings in the nipples not being used are plugged with plugs made for the purpose.

Figure 12-22 shows a closure made for terminal blocks. When only one cable enters, the vacant nipple is plugged.

SPLICING DIRECT-BURIAL CABLE

Direct-burial cable is buried in a trench, usually at least 30 inches below the surface. When a splice must remain external to the ground, splice housings or terminal housings are used. When no external housings are permitted, a casting compound and special splicing technique is used to allow the splice to remain underground.

When the cable changes from direct-burial cable to aerial cable, the housing is usually pole mounted. However, when a terminal block to connect lines to a telephone is needed, or when a splice is to be made in the cable, a pedestal-mounted housing is used.

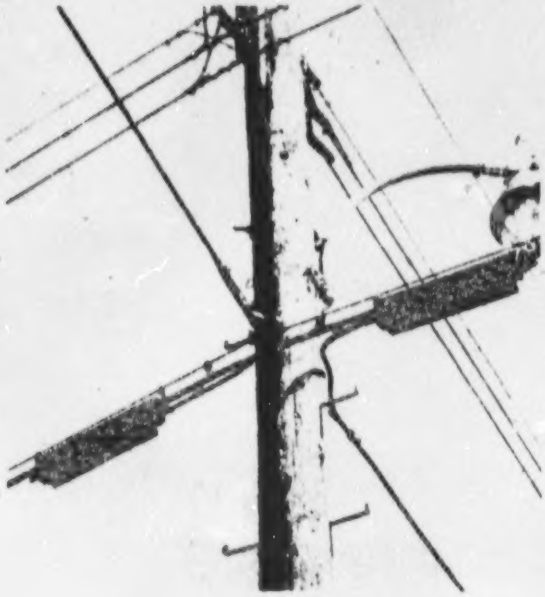
Figure 12-23 shows a pedestal-mounted open-terminal housing with three pairs of conductors connected to the terminal block. In this type of housing the conductors passing through the housing (not connected to the terminal block) are not cut, but are continuous through the housing. Figure 12-24 shows the housing with cover in place.

An example of a "splice housing" is shown in figure 12-25. Figure 12-26 shows the splice housing with cover in place. Continuity of the shield in direct-burial cable is accomplished by means of a "bonding harness" as shown in figure 12-27.

When no external housings are permitted, the technique shown in figure 12-28 indicates the use of casting compound to minimize the problem of moisture.

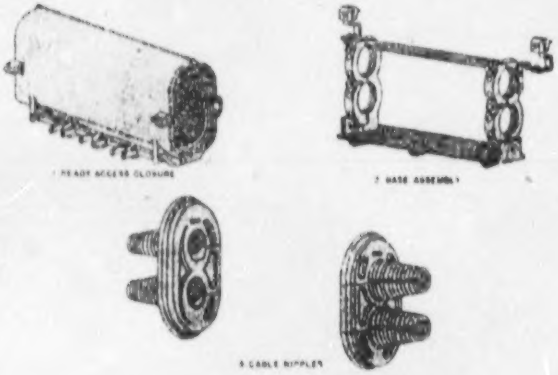
SPLICING PLASTIC-SHEATHED CABLE TO LEAD-SHEATHED CABLE

The method described here for joining plastic-sheathed, plastic-insulated cable to lead



73.211

Figure 12-20.—Splice closures in place.



73.212X

Figure 12-21.—Parts of a splice closure.

sheathed, paper-insulated cable may be used on aerial, direct-burial, or duct installations.

The method is illustrated in figures 12-29, 12-30, and 12-31. First mark the cable sheath with the location of the splice and place additional marks a standard distance on either side (4 inches on lead, 7 inches on plastic). With aerial-type cable, the cable on either side of the splice should lie along the suspension strand without bowing and without tension when the strand is at normal tension. The length of the splice opening and the size of the lead sleeve required are shown in fig. 12-29.

On the lead sheath end, carefully remove the desired amount of sheath so that the core wrapper or the insulation around the conductors will not be damaged. Scrape the surface of the lead 4 inches from the point where the sheath was cut, making sure to remove all dull spots and streaks to present a clean surface for wiping the lead joint. Coat this cleaned space with stearine. Then remove the core wrapper from the exposed cable.

On the plastic cable end, remove the sheath carefully for the desired distance so that the metal shield, the core wrapper, and the insulation around the conductors will not be damaged. Scuff the sheath of the cable for a distance of 7 inches from the opening, using No. 2 1/2 grade sandpaper. Do not use emery paper or cloth. This scuffing will ensure a satisfactory surface for the proper adhesion of the end seal casting and for the subsequent taping operations. Turn back the shield and remove the core wrapper to the end of the sheath opening.

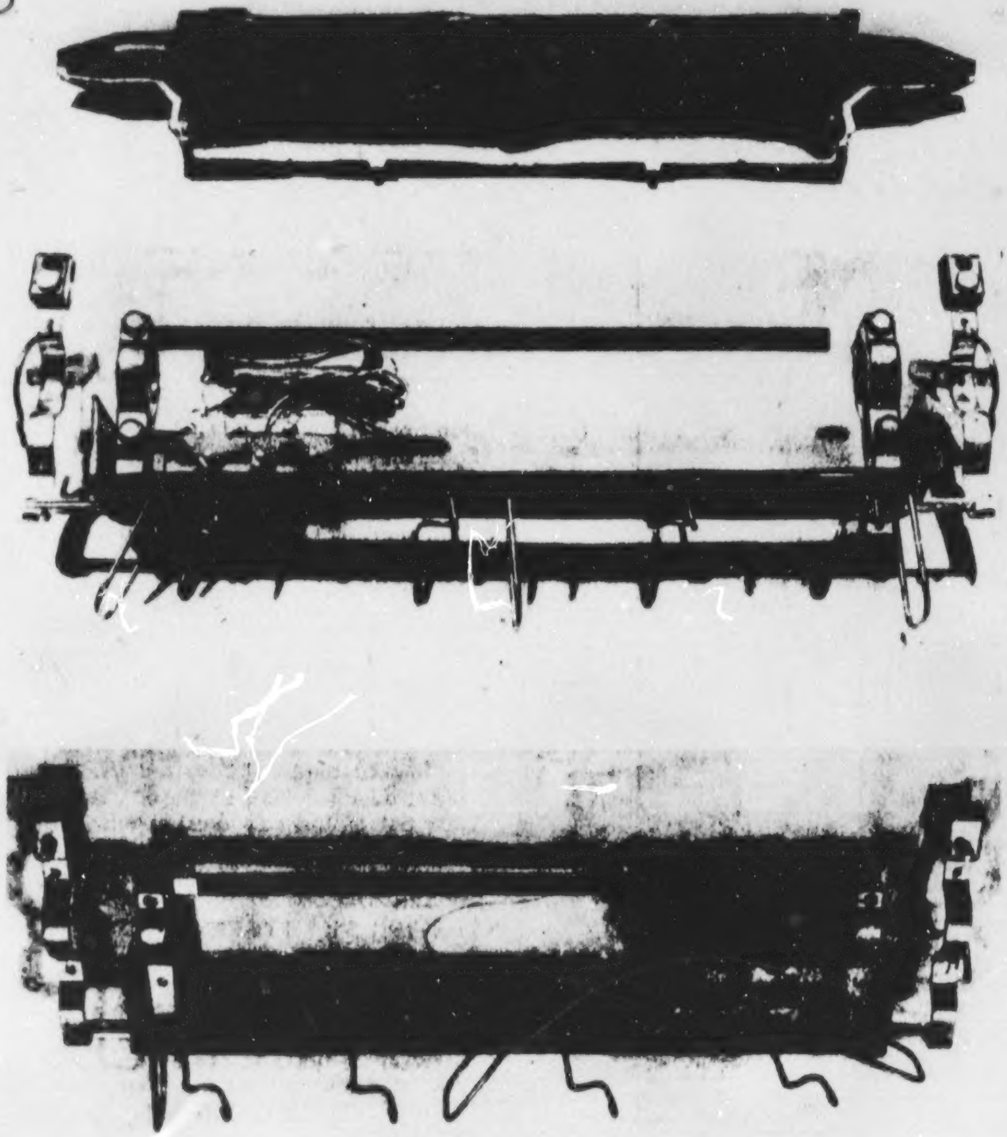
Select a lead sleeve of proper size. Clean the outside of the sleeve for a distance of 7 inches from the end toward the plastic-sheathed cable, and for a distance of 2 inches from the end toward the lead-sheathed cable. Place the sleeve over the lead-sheathed cable and push it back out of the way until needed, as shown in figure 12-29.

CASTING THE PLASTIC END SEAL

Prepare a cone-shaped casting form (one may be made from a cone-shaped paper cup or something similar). Be sure that the largest diameter of the form is not larger than the inside diameter of the lead sleeve being used. Fashion a hole in the bottom of the form to make a snug fit over the plastic-cable sheath. Slide the form over the sheath to a temporary position about 4 inches back from the end of the sheath. Turn up the end of the cable and secure it in a vertical position for the casting operation. Spread the conductors to allow space for the casting liquid to completely seal all voids.

Move the casting form up until it extends about 1/2 inch above the end of the plastic sheath. If the lower end of the form is not tight around the sheath, it may be necessary to use a few wraps of tape to hold it in position and seal

580



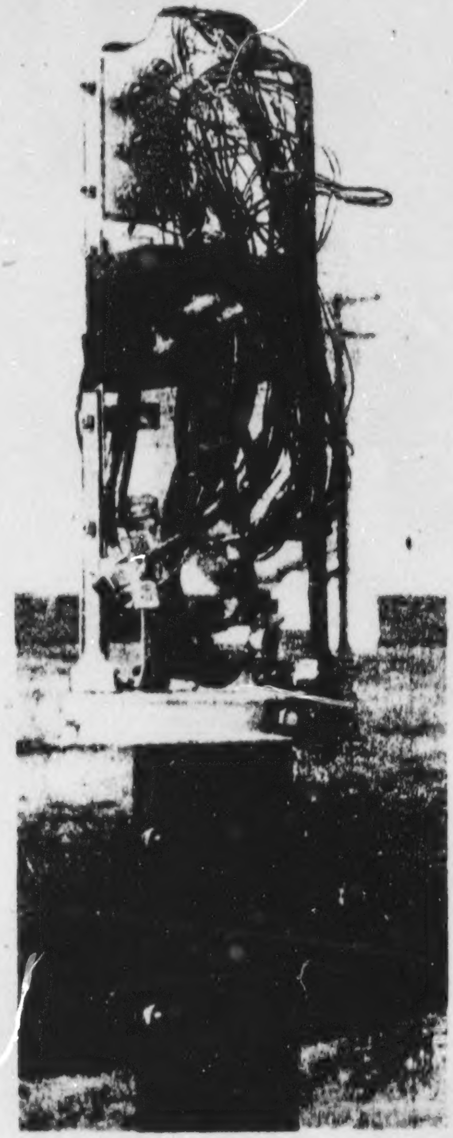
73.213

Figure 12-22.—Terminal-block closure.

any openings. Figure 12-29 shows the form in place ready to pour the casting mixture.

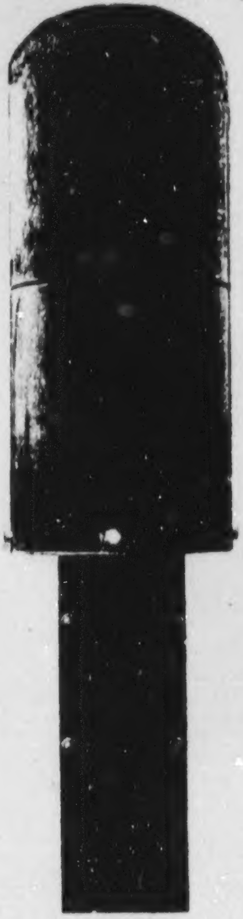
Prepare the casting mixture according to the instructions included with the container. You will notice that the casting resin will develop heat immediately after being mixed, but this heat will not cause any harm. When the mixture is ready to pour, pour it into the form until it reaches a point very close to the top. During the pouring process, move the wires and shield slightly to aid penetration and to bring the shield and wires into alignment for the splicing operation. After the form is filled, allow the mixture to harden for approximately

726



73.214
Figure 12-23.—Open-terminal housing.

10 minutes, or until it is firm and cool to the touch. Then peel off the form and clean off any particles that may have adhered to the casting. The cable then may be bent back into position for the splicing operation.

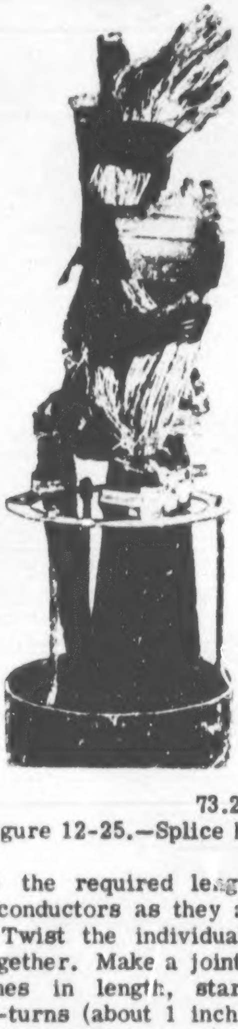


73.215
Figure 12-24.—Terminal housing with cover in place.

SPLICING AND SOLDERING CONDUCTORS

Separate conductors into bunches by color groups or complements, and secure them in a convenient position for splicing, leaving a suitable length for staggered spacing of splices to attain a uniform layup. Excess wire should then be cut off. As conductors are selected for splicing, plastic sleeves of proper diameter should be placed over one of the conductors and pushed back. Where conductors end in a splice, cut them off and place a sleeve (selected according to Fig. 12-30 specifications) over the ends and position it for subsequent use. All sleeves are 3 inches long.

582



73.216
Figure 12-25.—Splice housing.

Remove the required length of insulation from the conductors as they are selected for splicing. Twist the individual, skinned conductors together. Make a joint 1 3/8 inches to 1 3/4 inches in length, starting with three loose half-turns (about 1 inch), then finishing with five tight half-turns (about 3/8 to 1/2 inch).

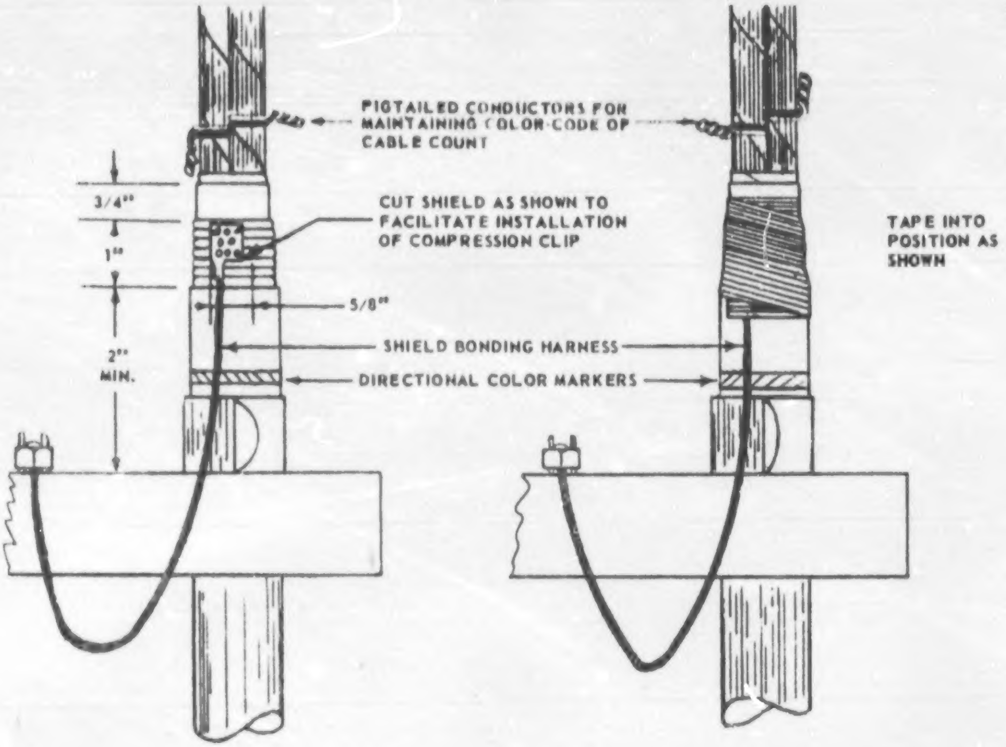
After the excess wire has been cut off, solder the joint using resin core solder. Bend the soldered pigtail into place, and slide the previously placed sleeve over the joint, as shown in figure 12-30.

After all conductors have been spliced and placed in the proper layup, wrap the body of the splice with a plastic envelope cut from a sheet of polyethylene or the equivalent. Fill the envelope with desiccant in amounts for various sizes of cable as shown in Fig. 12-30. BE SURE NOT TO EXCEED THE RECOMMENDED AMOUNTS.

73.217
Figure 12-26.—Splice housing with cover in place.

Cover the whole splice with a single layer of half-lapped-vinyl tape, but do not overlap the cable sheath or metallic shield. To ensure continuity of the shield, rewrap the shielding material around the splice, extending in onto the lead sheath. If the shield material is not long enough to make a full wrap around the lead sheath, add an extra piece of shielding and solder it to the existing strip. This soldering operation should be performed away from the cable core to protect the tape from the heat of the soldering iron. Solder the end of the shield to the lead sheath at the point of overlap. On aerial-type plastic cable, tin the aluminum shield with

728


PIGTAILED CONDUCTORS FOR MAINTAINING COLOR-CODE OF CABLE COUNT
3/4"
1"
CUT SHIELD AS SHOWN TO FACILITATE INSTALLATION OF COMPRESSION CLIP
TAPE INTO POSITION AS SHOWN
5/8"
2" MIN.
SHIELD BONDING HARNESS
DIRECTIONAL COLOR MARKERS

STEPS

1. REMOVE OUTER JACKET, TRIM CABLE SHIELD AND INNER JACKET AS ILLUSTRATED.
2. FOLD BACK OVERLAPPED EDGE OF SHIELD AND COMPRESS CLIP OF SHIELD BONDING HARNESS TO SHIELD AS SHOWN USING SPECIAL COMPRESSING TOOL.
3. APPLY VINYL TAPE OVER SHIELD AND BONDING HARNESS AS ILLUSTRATED. TAPE SHOULD BE APPLIED AS NEEDED TO PREVENT CONTACT BETWEEN SHIELD AND METAL OF TERMINAL HOUSING.
4. SECURE END OF SHIELD BONDING HARNESS IN SPLIT-BOLT GROUNDING CONNECTOR.

73.218

Figure 12-27.—Installation of bonding harness.

Alcoa 64 aluminum flux and solder it with 50-50 or resin core solder.

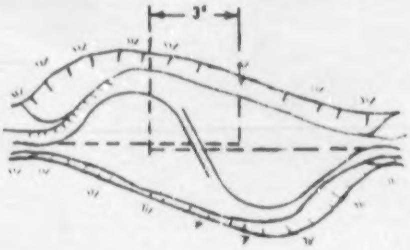
PLACING THE LEAD SLEEVE

Place a strip of tape on the plastic sheath extending lengthwise about 2 1/2 inches from the base of the cast end seal, as shown in figure 12-31. Secure a strip of wire cloth 2 inches wide, starting the edge of the wire cloth on the strip of tape and wrapping tightly around the cable, overlapping the starting point about 1 inch.

Secure the edges of the wire cloth in place with tape. Hold a hot soldering iron firmly against the wire cloth at numerous points around the sheath until dark patches appear through the wire mesh. This operation will, by softening the plastic, anchor the wire cloth in the plastic sheath. Be careful not to hold the iron too long in one place, or the insulation may be burned.

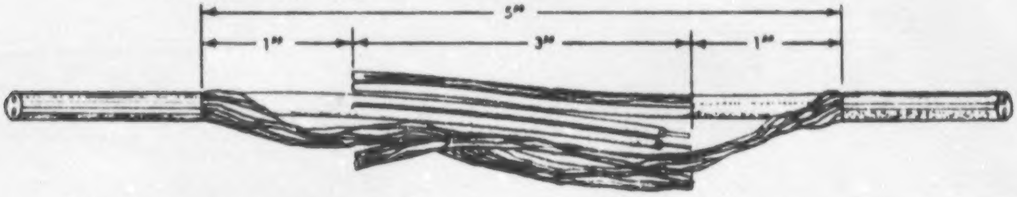
Place the lead sleeve in position over the splice, overlapping the lead-cable sheath about 1 1/2 inches, and overlapping the wire cloth on the plastic sheath about 1 inch. Beat in the end

584

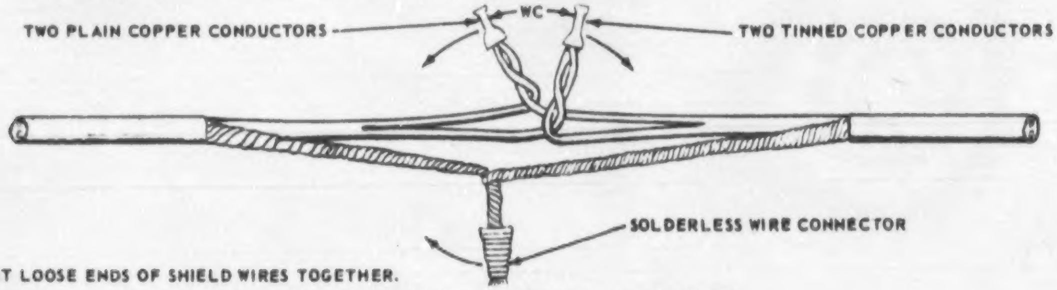


NOTE:

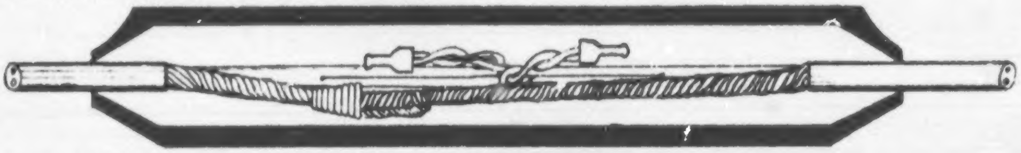
EXCAVATE A TRENCH AS SHOWN, PROVIDE A MINIMUM OF THREE FEET OVERLAP IN THE BURIED WIRE AND PROCEED TO MAKE THE DIRECT BURIAL WIRE SPLICE AS SHOWN IN THE FOLLOWING STEPS:



1. REMOVE APPROXIMATELY 4" OF JACKET FROM ENDS AS SHOWN. CLEAN FLOODING COMPOUND FROM SHIELD WIRES AND CONDUCTOR INSULATION.
2. SLIT INSULATION APPROXIMATELY 3" AND SEPARATE CONDUCTORS.
3. REMOVE APPROXIMATELY 1/4" OF INSULATION FROM CONDUCTORS, INSERT INTO INSULATED WIRE CONNECTORS, CRIMP AND BEND INTO POSITION AS SHOWN.


TWO PLAIN COPPER CONDUCTORS
WC
TWO TINNED COPPER CONDUCTORS
SOLDERLESS WIRE CONNECTOR

4. TWIST LOOSE ENDS OF SHIELD WIRES TOGETHER.
5. BRING SHIELD WIRES TOGETHER, MAKE PIGTAIL, INSERT ENDS INTO SOLDERLESS WIRE CONNECTOR AND TWIST INTO POSITION.
6. BRING SHIELDS AND CONDUCTOR SPLICES INTO ALIGNMENT AND APPLY TAPE AS REQUIRED TO OBTAIN COMPACT BUNDLE FOR POSITIONING IN MOLD.

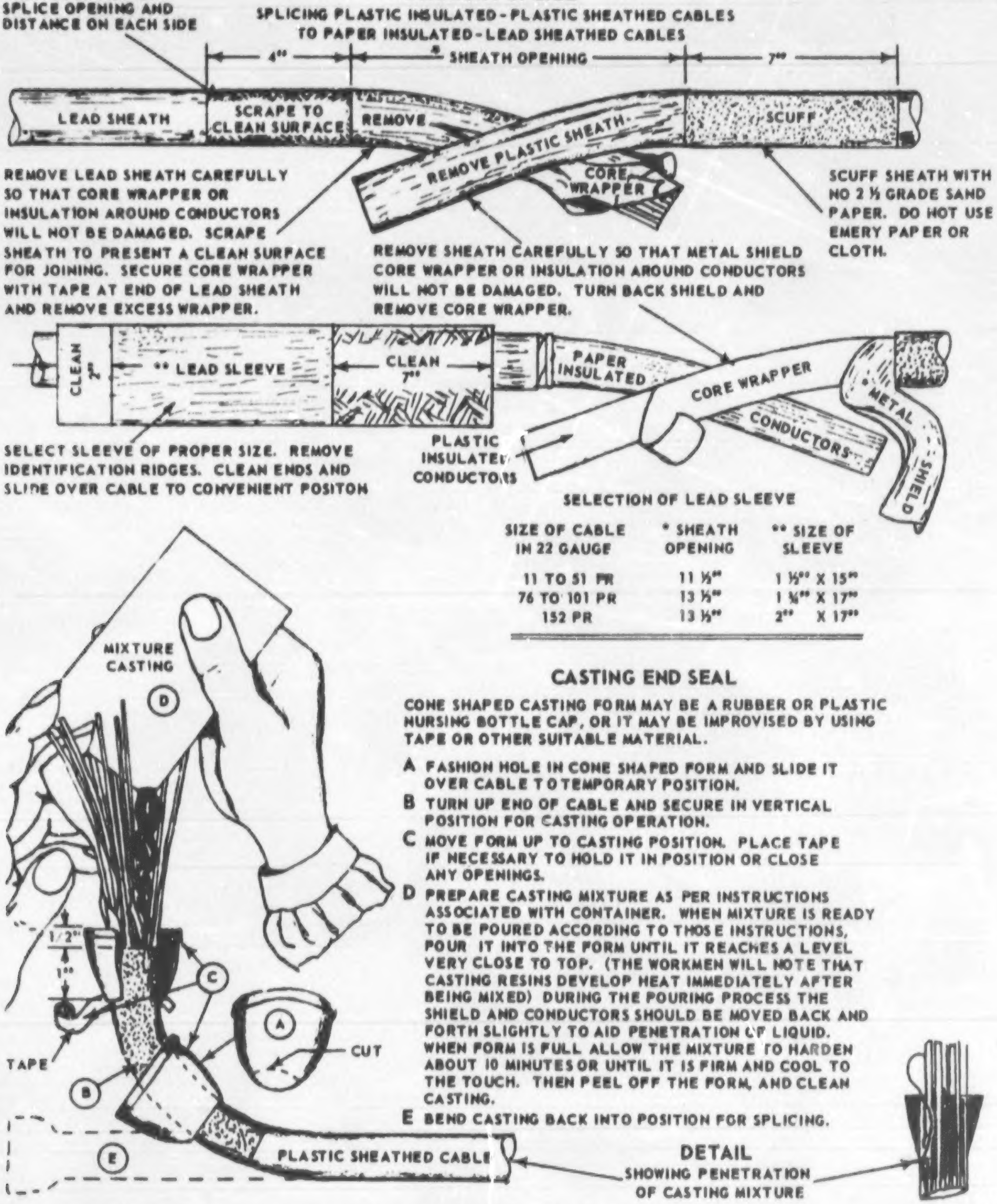


7. POSITION MOLD AROUND SPLICE BUNDLE AND APPLY TAPE AT EACH END TO PREVENT COMPOUND MIXTURE FROM LEAKING.
8. SET MOLD IN LEVEL POSITION, PREPARE CASTING COMPOUND AS RECOMMENDED BY MANUFACTURER AND POUR.
9. DO NOT DISTURB SPLICE OR REFILL TRENCH UNTIL CASTING COMPOUND HAS COMPLETELY CURED.

73.219

Figure 12-28.—Splicing direct-burial wire.

730



STRAIGHT SPLICE

SPLICING PLASTIC INSULATED-PLASTIC SHEATHED CABLES TO PAPER INSULATED-LEAD SHEATHED CABLES

MARK LOCATION OF SPLICE OPENING AND DISTANCE ON EACH SIDE

REMOVE LEAD SHEATH CAREFULLY SO THAT CORE WRAPPER OR INSULATION AROUND CONDUCTORS WILL NOT BE DAMAGED. SCRAPE SHEATH TO PRESENT A CLEAN SURFACE FOR JOINING. SECURE CORE WRAPPER WITH TAPE AT END OF LEAD SHEATH AND REMOVE EXCESS WRAPPER.

REMOVE SHEATH CAREFULLY SO THAT METAL SHIELD CORE WRAPPER OR INSULATION AROUND CONDUCTORS WILL NOT BE DAMAGED. TURN BACK SHIELD AND REMOVE CORE WRAPPER.

SCUFF SHEATH WITH NO 2 ½ GRADE SAND PAPER. DO NOT USE EMERY PAPER OR CLOTH.

SELECT SLEEVE OF PROPER SIZE. REMOVE IDENTIFICATION RIDGES. CLEAN ENDS AND SLIDE OVER CABLE TO CONVENIENT POSITON

SELECTION OF LEAD SLEEVE

SIZE OF CABLE IN 22 GAUGE	* SHEATH OPENING	** SIZE OF SLEEVE
11 TO 51 PR	11 ½"	1 ½" X 15"
76 TO 101 PR	13 ½"	1 ⅝" X 17"
152 PR	13 ½"	2" X 17"

CASTING END SEAL

CONE SHAPED CASTING FORM MAY BE A RUBBER OR PLASTIC NURSING BOTTLE CAP, OR IT MAY BE IMPROVISED BY USING TAPE OR OTHER SUITABLE MATERIAL.

A FASHION HOLE IN CONE SHAPED FORM AND SLIDE IT OVER CABLE TO TEMPORARY POSITION.

B TURN UP END OF CABLE AND SECURE IN VERTICAL POSITION FOR CASTING OPERATION.

C MOVE FORM UP TO CASTING POSITION. PLACE TAPE IF NECESSARY TO HOLD IT IN POSITION OR CLOSE ANY OPENINGS.

D PREPARE CASTING MIXTURE AS PER INSTRUCTIONS ASSOCIATED WITH CONTAINER. WHEN MIXTURE IS READY TO BE POURED ACCORDING TO THOSE INSTRUCTIONS, POUR IT INTO THE FORM UNTIL IT REACHES A LEVEL VERY CLOSE TO TOP. (THE WORKMEN WILL NOTE THAT CASTING RESINS DEVELOP HEAT IMMEDIATELY AFTER BEING MIXED) DURING THE POURING PROCESS THE SHIELD AND CONDUCTORS SHOULD BE MOVED BACK AND FORTH SLIGHTLY TO AID PENETRATION OF LIQUID. WHEN FORM IS FULL ALLOW THE MIXTURE TO HARDEN ABOUT 10 MINUTES OR UNTIL IT IS FIRM AND COOL TO THE TOUCH. THEN PEEL OFF THE FORM, AND CLEAN CASTING.

E BEND CASTING BACK INTO POSITION FOR SPLICING.

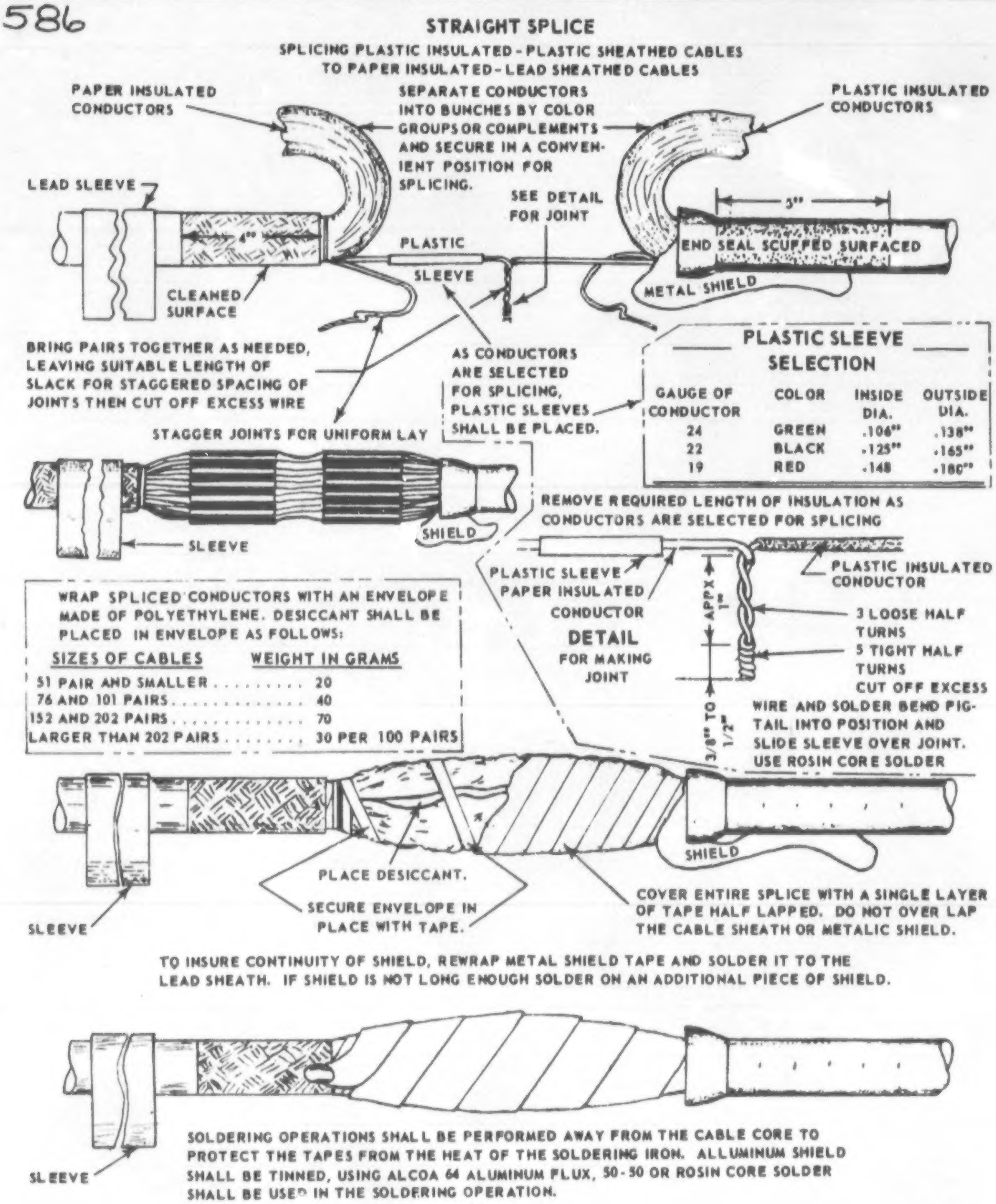
DETAIL SHOWING PENETRATION OF CASTING MIXTURE

4"
* SHEATH OPENING
7"
LEAD SHEATH
SCRAPE TO CLEAN SURFACE
REMOVE
REMOVE PLASTIC SHEATH
CORE WRAPPER
SCUFF
CLEAN 2"
** LEAD SLEEVE
CLEAN 7"
PAPER INSULATED
CORE WRAPPER
CONDUCTORS
METAL SHIELD
PLASTIC INSULATED CONDUCTORS
MIXTURE CASTING
D
1/2"
1"
C
A
CUT
TAPE
B
E
PLASTIC SHEATHED CABLE

Figure 12-29.—Joining plastic-sheathed cable to lead-sheathed cable. (1) Preparing for the splice.

73.220

586



STRAIGHT SPLICE

SPLICING PLASTIC INSULATED - PLASTIC SHEATHED CABLES TO PAPER INSULATED - LEAD SHEATHED CABLES

PAPER INSULATED CONDUCTORS
PLASTIC INSULATED CONDUCTORS
LEAD SLEEVE
SEE DETAIL FOR JOINT
4"
3"
END SEAL SCUFFED SURFACED
PLASTIC SLEEVE
CLEANED SURFACE
METAL SHIELD
STAGGER JOINTS FOR UNIFORM LAY
SHIELD
SLEEVE
PLASTIC SLEEVE
PAPER INSULATED CONDUCTOR
PLASTIC INSULATED CONDUCTOR
DETAIL FOR MAKING JOINT
APPX 1"
3 LOOSE HALF TURNS
5 TIGHT HALF TURNS
3/8" TO 1/2"
PLACE DESICCANT.
SECURE ENVELOPE IN PLACE WITH TAPE.
SHIELD
SLEEVE
SLEEVE

SEPARATE CONDUCTORS INTO BUNCHES BY COLOR GROUPS OR COMPLEMENTS AND SECURE IN A CONVENIENT POSITION FOR SPLICING.

BRING PAIRS TOGETHER AS NEEDED, LEAVING SUITABLE LENGTH OF SLACK FOR STAGGERED SPACING OF JOINTS THEN CUT OFF EXCESS WIRE

AS CONDUCTORS ARE SELECTED FOR SPLICING, PLASTIC SLEEVES SHALL BE PLACED.

PLASTIC SLEEVE SELECTION

GAUGE OF CONDUCTOR	COLOR	INSIDE DIA.	OUTSIDE DIA.
24	GREEN	.106"	.138"
22	BLACK	.125"	.165"
19	RED	.148	.180"

REMOVE REQUIRED LENGTH OF INSULATION AS CONDUCTORS ARE SELECTED FOR SPLICING

CUT OFF EXCESS WIRE AND SOLDER BEND PIGTAIL INTO POSITION AND SLIDE SLEEVE OVER JOINT. USE ROSIN CORE SOLDER

WRAP SPLICED CONDUCTORS WITH AN ENVELOPE MADE OF POLYETHYLENE. DESICCANT SHALL BE PLACED IN ENVELOPE AS FOLLOWS:

SIZES OF CABLES	WEIGHT IN GRAMS
51 PAIR AND SMALLER	20
76 AND 101 PAIRS	40
152 AND 202 PAIRS	70
LARGER THAN 202 PAIRS	30 PER 100 PAIRS

COVER ENTIRE SPLICE WITH A SINGLE LAYER OF TAPE HALF LAPPED. DO NOT OVER LAP THE CABLE SHEATH OR METALIC SHIELD.

TO INSURE CONTINUITY OF SHIELD, REWRAP METAL SHIELD TAPE AND SOLDER IT TO THE LEAD SHEATH. IF SHIELD IS NOT LONG ENOUGH SOLDER ON AN ADDITIONAL PIECE OF SHIELD.

SOLDERING OPERATIONS SHALL BE PERFORMED AWAY FROM THE CABLE CORE TO PROTECT THE TAPES FROM THE HEAT OF THE SOLDERING IRON. ALLUMINUM SHIELD SHALL BE TINNED, USING ALCOA 64 ALUMINUM FLUX, 50-50 OR ROSIN CORE SOLDER SHALL BE USED IN THE SOLDERING OPERATION.

Figure 12-30.—Joining plastic-sheathed cable to lead-sheathed cable. (2) Making the splice.

73.221

587

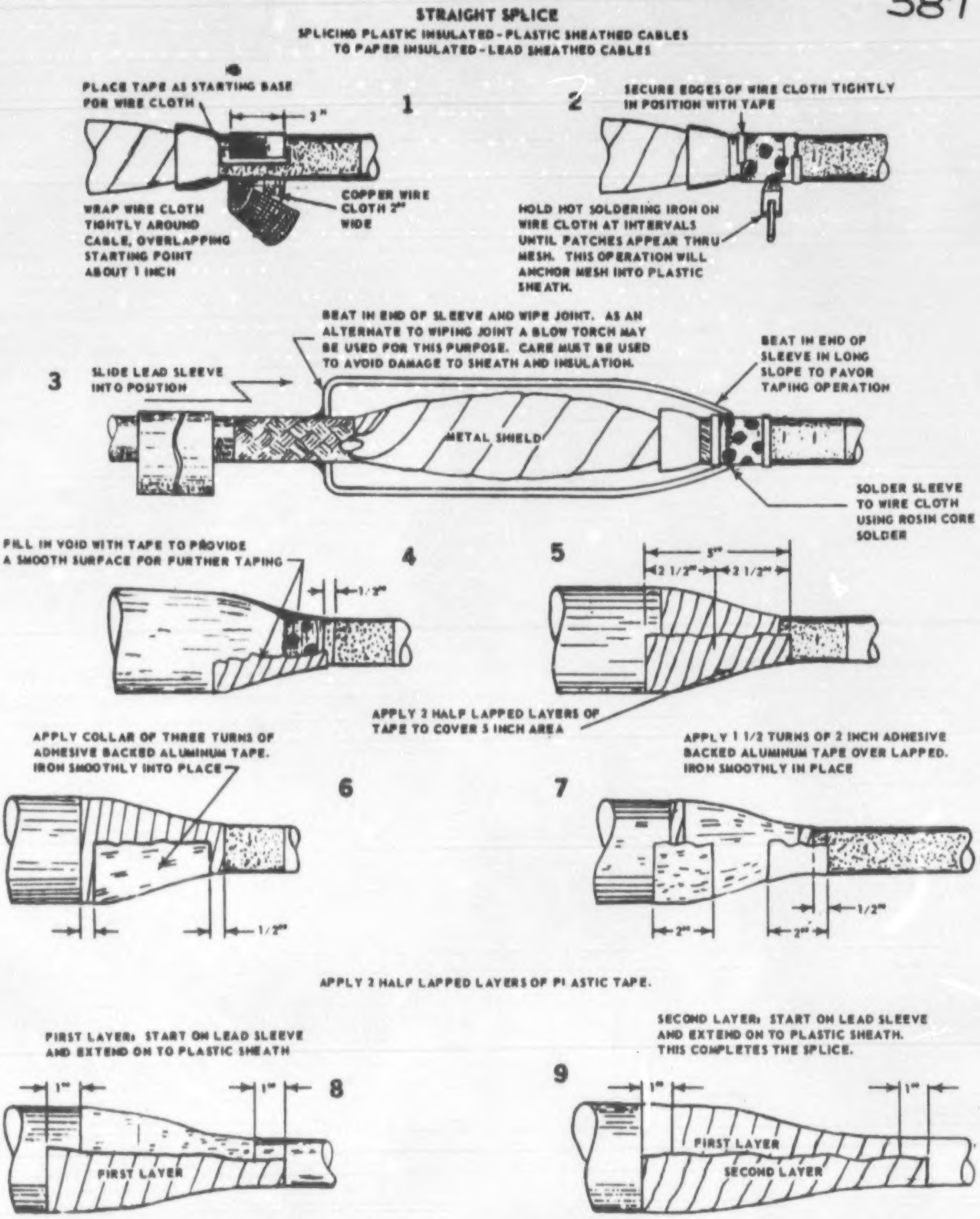

STRAIGHT SPLICE
SPLICING PLASTIC INSULATED - PLASTIC SHEATHED CABLES
TO PAPER INSULATED - LEAD SHEATHED CABLES
1
PLACE TAPE AS STARTING BASE FOR WIRE CLOTH
2"
WRAP WIRE CLOTH TIGHTLY AROUND CABLE, OVERLAPPING STARTING POINT ABOUT 1 INCH
COPPER WIRE CLOTH 2" WIDE
2
SECURE EDGES OF WIRE CLOTH TIGHTLY IN POSITION WITH TAPE
HOLD HOT SOLDERING IRON ON WIRE CLOTH AT INTERVALS UNTIL PATCHES APPEAR THRU MESH. THIS OPERATION WILL ANCHOR MESH INTO PLASTIC SHEATH.
3
SLIDE LEAD SLEEVE INTO POSITION
BEAT IN END OF SLEEVE AND WIPE JOINT. AS AN ALTERNATE TO WIPING JOINT A BLOW TORCH MAY BE USED FOR THIS PURPOSE. CARE MUST BE USED TO AVOID DAMAGE TO SHEATH AND INSULATION.
BEAT IN END OF SLEEVE IN LONG SLOPE TO FAVOR TAPING OPERATION
METAL SHIELD
SOLDER SLEEVE TO WIRE CLOTH USING ROSIN CORE SOLDER
4
FILL IN VOID WITH TAPE TO PROVIDE A SMOOTH SURFACE FOR FURTHER TAPING
1/2"
5
5"
2 1/2"
2 1/2"
APPLY 2 HALF LAPPED LAYERS OF TAPE TO COVER 5 INCH AREA
6
APPLY COLLAR OF THREE TURNS OF ADHESIVE BACKED ALUMINUM TAPE. IRON SMOOTHLY INTO PLACE
1/2"
7
APPLY 1 1/2 TURNS OF 2 INCH ADHESIVE BACKED ALUMINUM TAPE OVER LAPPED. IRON SMOOTHLY IN PLACE
1/2"
2"
2"
APPLY 2 HALF LAPPED LAYERS OF PLASTIC TAPE.
FIRST LAYER: START ON LEAD SLEEVE AND EXTEND ON TO PLASTIC SHEATH
8
1"
1"
FIRST LAYER
SECOND LAYER: START ON LEAD SLEEVE AND EXTEND ON TO PLASTIC SHEATH. THIS COMPLETES THE SPLICE.
9
1"
1"
FIRST LAYER
SECOND LAYER

Figure 12-31.—Joining plastic-sheathed cable to lead-sheathed cable.
(3) Completing the splice.

73.222

733

of the sleeve on the lead-sheath side and wipe in the usual manner.

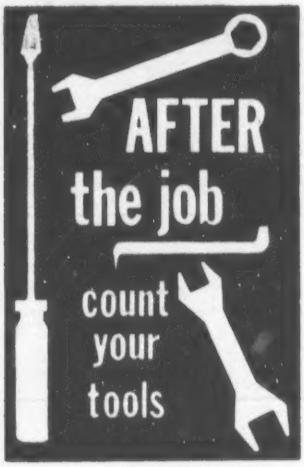
On the plastic-sheath side, shape the end of the lead sleeve to the copper-wire cloth in a gradually tapering slope. This will tend to make the taping operation easier. Solder the lead sleeve to the wire cloth, using resin-core solder and a soldering copper.

Fill in the void between the plastic sheath and the lead sleeve with tape, to provide a smooth surface for further taping. Figure 12-31 shows the taping procedure. Apply two half-lapped layers of tape, extending 2 1/2 inches on each side of the point where the lead sleeve is joined to the wire cloth (meaning: a total extent of 5 inches). Apply a collar of three turns of 3-inch adhesive-backed aluminum tape and iron smoothly in place with a cable dresser. This operation will allow 1/2 inch of previously placed vinyl tape to show at each end of the collar.

Apply one and a half turns of 2-inch adhesive-backed aluminum tape at each end of the collar, overlapping the previously placed aluminum tape about 1/2 inch. Iron smoothly with a cable dresser. Two-inch tape may be cut from a roll of 4-inch tape.

Apply two half-lapped layers of vinyl tape over the aluminum tape. Start the first layer on the lead sleeve 1 inch from the aluminum tape, and continue to a point on the plastic sheath 1 inch beyond the aluminum tape. Start the second layer of tape on the lead sleeve 1 inch from the end of the previous layer, and wrap to a point 1 inch beyond the end of the first layer.

This completes the splicing operation.



734